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SCIENCE AND TECHNOLOGY

No. 84

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On behalf of all of us in FBIS I wish to express appreciation to our readers who have guided our efforts throughout the years.

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CHINA REPORT

SCIENCE AND TECHNOLOGY

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NATIONAL DEVELOPMENT

AWARDS GIVEN FOR MAJOR SCIENTIFIC INVENTIONS

OW140752 Beijing XINHUA in English 0732 GMT 14 Feb 81

[Text] **Beijing, 14 Feb (XINHUA)--Technology for blast furnace smelting** of vanadium-titanium magnetite with high titanium content devised by the experimental group of the Panzhihua Iron and Steel Company in Sichuan Province received the only first class award given by the State Scientific and Technological Commission in the period from April 1979 to 30 Ja-uary 1981.

The commission announced that 165 major scientific inventions were recognized and given awards by the recommendation and examination committee.

The breakthrough in smelting and polymetallic ore has been sought by scientists abroad for over a hundred years. Panzhihua has vast reserves of the vanadium, titanium and iron ore and the invention will accelerate its development and use.

Inventions recognized and given awards by the commission's recommendation and examination committee must be major, original achievements, up to advanced world levels. The committee classifies such inventions according to their applicability. Twenty-three inventions received second class awards, 111, third class awards and 30, fourth class awards.

The majority of the inventions are new industrial technologies. Second in number are scientific achievements in agriculture and medical science.

The large-size synthetic fluoro-phlogopite (a kind of mica) manufactured by scientists at the Shanghai Institute of Silicate Research under the Chinese Academy of Sciences received a second class award. This is an essential material in the electronics industry.

Medical scientists in the Chinese Academy of Medical Sciences in coordination with scientists from other units were given a third class award for making a new medicine to treat the disease, leptospirosis.

A mulching agent, which increases the temperature of the soil, received a fourth class award. It was produced by scientists at the Institute of Geography under the Chinese Academy of Sciences and the Dalian general oils and fats plant.

The recommendation and examination committee for inventions was set up in April 1979 by the State Scientific and Technological Commission in accordance with a regulation of the State Council. Its aim is to encourage initiative and creativeness on the part of scientists and technologists for the country's socialist modernization drive. The committee is composed of 32 leading scientists and technologists including physicist Qian Xuesen, medical scientist Huang Jiasi, agronomist Jin Shanbao and optics specialist Wang Daheng.

CSO: 4020

BRIEFS

STUDENTS' PHYSICAL DATA--Beijing, 22 Jan (XINHUA)--Over 200,000 students in China from age 7 to 25 years have been given physical checkups in a 2-year study. This first mass study of its kind done in China was a joint undertaking by the State Physical Culture and Sports Commission, Ministry of Education and Ministry of Public Health. The 23 items covered included blood pressure, pulse, vital capacity, height, weight, chest measurement, doing sit-ups, standing long jumps and different kinds of running. Beijing students in the 18-25 age group ranked first for average height and weight, but those from Guangdong Province had the best physique. Every decade from 1955 to 1979 has shown an improvement in the size of China's children, boys in the 7-18 age group have averaged a 2.3 cm increase in height with a weight gain of 1.35 kgs. For girls, the increase in height has been 2.10 cm and 0.90 kgs in weight. The 4.4 million data collected have already provided material for 150 academic papers. [Beijing XINHUA in English 0250 GMT 22 Jan 81]

CSO: 4020

PHYSICAL SCIENCES

SCOPE, TASKS OF THIRTY YEARS OF CHEMICAL ANALYSIS REVIEWED

Jilin FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 8 No 2, 1980 pp1-32

[Article by Liang Shuquan [2733 2885 2938], Zeng Yune [2582 0061 7725], Chen Yongzhao [7115 3057 0340] and Dong Wantang [5516 5502 1016]: "Thirty Years of Chemical Analysis in China"]

[Text] Foreword

Before discussing this topic, it is necessary to define the scope of chemical analysis--what exactly does it encompass? Some people equate chemical analysis with classical analysis. This definition is somewhat overly narrow. If we use the principles used in the method of analysis to define it, then analytical methods designed on the basis of chemical principles belong to chemical analysis and those based on physical principles belong to instrumental analysis. Such a classification may be accepted by chemical workers. Therefore, chemical analysis should include sample analysis (dissolution and melting), separation, chemical determination and measurement. The application of sampling and statistics in analytical chemistry (accuracy, precision, data processing, design of research work), automation of analysis, application of the computer can be isolated as a branch parallel to chemical analysis and instrumental analysis.

Analysis of organic elements, analysis of some functional groups and spot tests also belong within the scope of chemical analysis.

Chemical analysis and instrumental analysis are both two constituent parts of analytical chemistry. Since liberation, chemical analysis has had an important function in our nation's socialist construction. For example, in new technology and technological processes, chemical analysis has been widely used in microanalysis and trace analysis to solve analytical problems of such special materials as ancient relics, biological hormones, man-made elements and semiconductors and atomic energy.

Generally speaking, the achievements of workers in chemical analysis of the past 30 years have been positive. This can be seen from the articles published in the various kinds of academic publications, comprehensive reports and commentaries. Yet during this period, an even greater achievement is combining efforts with various productive construction work to solve their analytical problems, for example, analysis of the dolomitic iron ore of Nei Monggol, full analysis of the

tungsten mines of Huanan, metallurgy, oceanographic chemistry, semiconductor, petroleum and other chemical industries, and countless others. It is a pity that since 1966, research work has been sabotaged, and at present it is being actively revived and reorganized but more time is needed. Workers in chemical analysis of course should see that their responsibility is heavy and their future is bright. If they can join together with workers in instrumental analysis and work together, supplement each other, learn the strong points of others to make up for one's shortcomings, then, it is deeply believed that in the march towards the four modernizations, the development, expansion, weeding through the old to bring forth the new in our nation in analytical chemistry will come without doubt.

Because of the editorial limitations and the urgency of time, we have not been able to review all the work involved in chemical analysis, but several topics of chemical analysis--separation and concentration, complexometric titration, photometric analysis--have been selected as representatives. It is hoped that with more time in the future, other articles can be written to discuss the other aspects.

Separation and Concentration

The main task of analytical chemistry is to determine and measure the composition of matter. To achieve the goal of determination and measurement, one must concentrate the components to be measured and separate or mask the components that interfere with measurements. The methods of separation and concentration can be divided into five types: 1. precipitation; 2. extraction; 3. column liquid phase layer analysis; 4. paper layer analysis, electrophoresis and laminar analysis; 5. other separation methods. These methods refer to those that are still not frequently used in inorganic chemical analysis such as concentration by fusion, separation by distillation and gas phase chromatography. The five types above are separately described below:

(I) Separation by Precipitation

The precipitate formed in a concentrated solution of a small volume is denser, the surface area is small, less impurities are adsorbed, for example, ammonium chloride and concentrated ammonia water can quantitatively separate iron and copper ions.[1] In steel analysis, the use of small volumes to separate interfering elements is based on the belief that the course of small volume precipitation is polymerization and dehydration.[2] The initial even precipitate hydrolyzes urea slowly to produce ammonia. This is the method of controlling the speed of production of precipitates. The latter method of even precipitation is used in precipitating tungstic acid, causing the complex ions of tunstic acid to gradually dissolve so that tunstic acid precipitates evenly. This is the method[3] of precipitation to control the speed of release of ions of metallic content. This method has opened up a new path for even precipitation in gradually oxidizing cerium (III) ions in a solution in which iodic acid exists to become cerium (IV) ions.[4] The ceric iodate precipitate thus formed has a dense property and it is easy for filtration and washing. This method can completely separate cerium from other lanthanides. The N-nitroso-phenylhydroxylamine formed in an acidic medium by phenylhydroxylamine and sodium nitrite can quantitatively precipitate zirconium and form a constant precipitant which will not dissolve at 130°C, and it can be directly weighed.[5] Our nation does not produce a lot of bromine, thus p-chloro-amaric acid was used as a substitute for p-bromo-amaric acid on a trial basis for precipitation and separation of trace amounts of zirconium in steel and iron, and the same results were obtained.[6] The inorganic precipitating agent ferriammonium fluoride is a new precipitating agent for sodium and has been used for measuring sodium in rocks.[7] Ceric cerium and thorium are both quadrivalent and using ceric cerium and ceric iodate together to precipitate thorium can quantitatively separate trace amounts of thorium from rare earth other than cerium.[8] Using organic reagents and controlling the appropriate pH values can separate thorium and scandium.[9] Using sodium hydroxide to precipitate and separate trace elements from low alloy steel can avoid loss due to adsorption. The selectivity of sodium hydroxide in separating rare earth can be increased by using triethanolamine to mask iron and aluminum, using hydrogen peroxide and EDTA to mask titanium, ethyl diamine to mask nickel, cobalt and copper, and oxidizing chromium (III) in an alkaline medium by hydrogen peroxide to become chromium (IV). The percentage of retrieval can reach 90 percent. The first precipitant will still contain interfering elements, and later in azo-arsine III colorimetric determination, Zn-EDTA still has to be added. Sulfosalicylic acid masks aluminum and amaric acid can mask titanium to eliminate interference. This method is suited for analysis of nickel based and iron based alloys containing over 0.001 percent of rare earth.[10] A continuous dilution method using multiple radioactive isotopes was proposed for measuring cesium by using phosphomolybdic acid to precipitate cesium phosphomolybdic acid, then by forming a saturated solution, and separating an equivalent amount of cesium using the property that the solubility of not easily soluble compounds does not change under definite conditions and the specific ability of the continuous dilution method to measure trace amounts of substances. The error in measuring one microgram of cesium is not greater than ±20 percent.[11]

(II) Separation by Extraction

The properties of PMBP (1-phenyl-3-methyl-4-benzoyl pyrazole-5-ketone) are superior to TTA (2-thenoyltrifluoroacetone) frequently used in foreign nations and phosphorous and amine extracting agents are also given attention. The domestically produced N-235 (mainly tri-n-octyl amine) has already been used in the determination of some impure elements in such pure metals as nickel, cobalt, copper and zinc.[12] Using ammonium sulfocyanic acid and sulfosalicylic acid as masking agent has brought about a method of using PMBP to extract and separate rare earth from a massive amount of coexisting elements. The results of combining this method with the azo-arsine III colorimetric method to separate trace amounts of rare earth from nickel based high temperature alloys (frequently containing tungsten, molybdenum, chromium, vanadium, titanium, zirconium, nicobium, iron, aluminum, cobalt, copper, manganese, and rare earth elements) were good.[13] The method is faster and simpler than sodium hydroxide precipitation and separation. Chelate compounds of PMBP-vanadium (V) were used to oxidize cerium in the organic phase after extraction of rare earth elements by PMBP (or other oxidizing agents such as hydrogen peroxide). First, trivalent rare earth elements were extracted in reverse from a pH-2 hydrochloric acid solution, then 2 percent ascorbic acid was used for reduction and reverse extraction of cerium, thus extracting and separating cerium from the other trivalent rare earth.[14]PMBP was used to extract and separate trace amounts of rare earth elements from large quantities of phosphate. By increasing the concentration of PMBP, the allowable amount of phosphate radicals can be increased to 20 milligrams[15] or the method of controlling the pH values of extraction[16] can be used. But the allowable amount of phosphate radicals is still not high, thus an auxiliary extraction system of benzene-isoamyl alcohol (4:1) is used. The capability of PMBP to extract rare earth is strengthened, the pH value of extraction is lowered, and the effect of the phosphate radical upon the extraction of rare earth elements is suppressed. At pH 4.2, 100 micrograms of cerium[17] can be quantitatively extracted from 500 milligrams of phosphate radicals or calcium phosphate. Trace amounts of calcium in steel can be extracted by the PMBP-4-methyl amyl-2-ketone solution, and by reverse extraction using a pH 3.5 solution, calcium can be determined by the ethyl dia etal (p-amino-phenol) colorimetric method. The lower limit of such determination is $5 \times 1 - ^{-4}$percent.[18] The use of PMBP ammonium sulfocyanate in 10-12 N sulfuric acid and 8-10 N hydrochloric acid to extract tungsten can reach an extraction percentage of 90 and 100 percent respectively. It can also be used to separate micrograms of tungsten.[19] In the presence of antimony tetrabenzol sulfate, the retrieval rate of using carbon tetrachloride to extract fluorine when the fluorine content is between 2 and 10 micrograms is greater than 95 percent. The sensitivity of using morin fluorescence to detect fluorine in aluminum can reach 2×10^{-3} microgram/milliliter.[20] In a sulfuric acid medium with the presence of oxalic acid and ammonium sulfocyanate, carbon tetrachloride was used to extract molybdenum and the complex compounds of N-benzoyl-N-phenylhydroxylamine (BPHA), then a mixed solution of crystalline benzo violet-ethyl alcohol is used for extraction to determine trace amounts of molybdenum in highly pure metallic zirconium.[21] This method is more sensitive than the method of using sulfocyanates and phenol disulfides (5×10^{-5}percent). This method is also relatively simple. At present, an effective separation method for the determination of zinc in minerals is still lacking. One method uses the benzene solution of tri-n-octyl phosphine oxide (TOPO) to extract zinc in hydrochloric solution. In an organic layer, 0.01 percent of zinc[22] can be determined by adding an ethyl alcohol solution of a copper reagent and by reverse extraction via perchloric acid and coloration by a zinc reagent in the liquid phase. Gold and halogen ions and nitrates can form hydrophobic complex anions, and in a diluted agua regia medium, benzene can be used to extract peacock green complex compounds of gold and the photometric method can be used to detect gold.[23] Because extraction eliminates interference and because it is unnecessary to eliminate nitrate, this method is a simple method to determine gold. The percentage of extraction of ethyl violet BF_4^- compounds using benzene as the extracting solution and coloration of the alkaline dye cations and BF_4^- complex anions is above 95 percent.[24] This method has produced satisfactory results in determining trace amounts of boron in aluminum alloys.[25] Complex compounds formed by diethyl dithiophosphoric acid and palladium and silver can be extracted by organic solvents. Rhodium and iridium remain in water, and when it is sufficiently dark, platinum can also remain quantitatively in the liquid phase.[26] This may be because the process of the reduction of platinum (IV) to platinum (II) by the reagent is a photochemical reaction. After reduction, platinum (II) forms an inner complex compound with the reagent and is extracted. In the presence of silver, the loss of platinum in the liquid phase is greater. The cause may be that the photochemical reaction of platinum is catalyzed by silver. Using a mixed solution of cyclohexane and n-butyl acetate (7:3) as the extracting agent can quantitatively extract pentavalent tungsten and can also separate large amounts of trivalent molybdenum.[27] This extraction method can separate tungsten from large amounts of molybdenum, vanadium, chromium, iron. Hexadecyl trimethyl ammonium bromide can cause azochlorophosphine III to react with thorium to form violet blue triple complex compounds. Equilibrium is easily reached when isoamyl alcohol-benzene is used for extraction, and 0.012 percent of thorium dioxide can be determined.[28] The condition of formation and composition of the triple complex compounds of titanium-N-cinnamoyl-N-o-methyl phenylhydroxylamine-sulfocyanate were studied and it was determined that the use of a concentration of 5-8 N of an extracting solution of hydrochloric acid used in the analysis of titanium in steel and iron is an easy method with a high sensitivity and good selectivity.[29] In addition, a lot of work has also been done in auxiliary extraction systems[30,31] and extraction mechanisms.

(III) Column Liquid Phase Layer Analysis

Highly pure beryllium oxide is an important material of atomic energy. It is required that the impure elements such as cadmium with an especially large sectional surface of absorption of thermal neutrons should be smaller than 10^{-6} - 10^{-5} percent. Using the cation exchange column and washing by EDTA can cause cadmium to flow out while beryllium still remains on the column. After the washing liquid condenses, determination can be carried out by photometry and the sensitivity can reach 5×10^{-6} percent.[32] The domestically manufactured multiporous cation exchange resin and α-hydroxy isobutyric acid used as the washing agent were used to separate six light rare earth elements (lanthium, cerium, praseodymium, neodymium, samarium, europium) from highly pure yttrium oxide by ion exchange layer analysis. It has been proven that under room temperature, using α- hydroxy isobutyric acid of a low concentration and a high pH value to wash yttrium, and then using α-hydroxy isobutyric acid of a higher concentration and high pH value to wash light rare earth impurities can concentrate light rare earth impurities to over 10,000 times, the average retrieval rate of the impurities is over 80 percent.[33] Eight kinds of impure elements in yttrium (Dy, Tb, Yb, Tm, Er, Ho, Gd, Sm) can be concentrated to 100 times[34] using acetic acid to wash the substance for 40 hours on a hydrogen type sulfonic acid group cation exchange resin. The strong spectral lines of a large number of cerium family rare earth elements cause interference of spectral lines and background effects in determining yttrium family rare earth elements. Washing with nitric-acid-methanol in a strongly alkaline anion exchange resin column can separate the light and heavy rare earth elements, then photometric determination can be performed to produce satisfactory results.[35] Nicobium can be more perfectly separated from other elements in steel in a polyethylene exchange column with a definite concentration of hydrochloric acid or hydrofluoric acid as the medium on the domestically manufactured 717 model strongly alkaline anion exchange resin column. The retrieval rate of niobium can reach 100 percent.[36] The method of using a small exchange column to separate zirconium and concentrating hafnium can quantitatively retrieve hafnium.[37] The small ion exchange column can lessen the washing volume, the Kd40 method can rapidly find the washing concentration and visibly hasten the speed of separation.[38] Besides using the ion exchange column, some work has also been done on the adsorption column, for example, after using agua regia to dissolve samples, the activated carbon adsorption column is used to separate gold.[39] This method, when compared to the flame test method, requires simple equipment and avoids high temperatures and lead poisoning. When compared to the wet hydroquinone titration method, it is faster. When chromium in the form of chromic acid ions or bichromic acid ions passes through an activated aluminum oxide layer analysis adsorption column, it is adsorbed, and other cations are not easily adsorbed, therefore, a small adsorption column can be used to separate concentrated trace amounts of chromium.[40] The static ion exchange method[41] and the use of acidic sodium chloride solution to soak and extract ionic rare earth from minerals and rare earth from rare earth catalysts[41A] have all been applied in analysis. These methods do not use hydrofluoric acid, they are simple, convenient and quick. Rare earth[42] of 0.2 microgram was quantitatively separated from 1 gram of highly pure uranium compounds using a mixed solution of hydrochloric acid and ammonium chloride as the washing agent on the zirconium tungstic acid column. Combination of the ion exchange method and the cyclic furnace technique can detect specific ions such as Az/Cd, U/Th, Fe/Co/Ni, Be/Al etc from mixtures.[43] This method can also be used on ion exchange resin paper and the results are good. Classical column liquid phase chromatography is being used less because it requires a lot of time. High speed liquid phase chromatography will develop rapidly to increase the speed of chromatographic separation and increase the efficiency of separation. Our nation has already successfully trial manufactured the high speed liquid phase chromatograph. The multiple ion exchange resin, large porous ion exchange resin and multiple high efficiency microdot silica gel of better properties have been successfully developed. They will quickly show outstanding achievements in separation and concentration and contribute to the four modernizations.

(IV) Paper Layer Analysis and Electrophoresis

Paper chromatography is an effective method of separating zirconium, hafnium, uranium, thorium and rare earth. Much research involving metals that are difficult to melt has already been done in our nation, and such research has been applied in geological exploration. For example, using normal amyl alcohol, methyl isomethylethyl ketone, methylethyl ketone and nitric acid as expanding agents to separate zirconium and hafnium requires only 4 hours, and at the same time, uranium, thorium and rare earth elements[44] can be separated. Domestically produced chromatographic paper with methylethyl ketone, 4-methyl amyl-2-ketone, nitric acid, water as expanding agents was used to separate uranium, thorium, scandium and rare earth elements and only 2 to 3 hours were needed and the results of separation were good.[45] The properties of rare earth elements are very similar and are very difficult to separate. Using paper layer analysis for separation is not difficult. The five elements lanthium, cereium, praseodymium, neodymium, and samarium[46] were satisfactorily separated on dongjie paper in experiments of the two kinds of solvent systems of tributyl phosphate, methylethyl ketone, ethyl acetate and tributyl phosphate, 4-methyl amyl-2-ketone, ethyl acetate. The cerium^{144} radioisotope was used to prove the positions of cerium spots. It was also proven that cerium was not mixed in with other spots. Using the solvent system of ethyl ether, acetone, sulfocyanate and bidirectional layer analysis can also separate the four elements of lanthium, praseodymium, neodymium and samarium.[46] Preliminary results have been obtained in separating rare earth elements by using tributyl phosphate, dioxane and nitric acid as expanding agents[47] and the method of reverse phase layer analysis.[48] The methyl acetate-nitric acid-water system was used as the expanding agent to separate rare earth and scandium, thorium, titanium and zirconium. It was also determined that the limit ratio of thorium and rare earth is 10^{-3}(49) when separated by tetrahydrofuran. Scandium can be separated from lanthanides, thorium and uranium using NH_4CNS-ethyl ether-acetone-hydrochloric acid as the expanding agent. The limit ratio of scandium and lanthium is 1:10000. Fourteen coloration agents were tested and xylenol orange, alizarine and quinone alizarine were the most sensitive. The detection limit reached 1 millimicrogram.[50] Using methylethyl keton-ethyl acetate-nitric acid-water as the expanding agent can also separate scandium from thorium, uranium and langthanide elements.[51] The tri-n-octyl amine-ammonium nitrate reverse phase paper layer analysis with NH_4NO_3-HNO_3 as the expanding agent can be used to separate lanthium, samarium, europium, gadolinium, yttrium and uranium. One microgram of samarium, europium or yttrium has been separated and detected in 1 milligram of lanthium. The method can also detect trace amounts of samarium, europium and gadolinium[52] from a large quantity of uranium. The factor of separating neighboring rare earth elements using HDEHP(P-204) toluene reverse phase paper layer analysis with 0.5N Na_2SO_4 acidic solution as the expanding agent reached 2.5 and the results were good.[53] Paper layer analysis can separate 15 kinds of rare earth elements but it is not perfect.[54] Individual elements still linger and sports are still connected to each other. Some people have added pentanone-2 in this system and 15 kinds of rare earth elements can be separated at once but the results are still not satisfactory and further studies are required.[55] Achievements have also been made in reverse phase paper layer analysis to separate the four elements of rhenium, vanadium, molybdenum, tungsten[56] and the separation of ions of alkali metals using the inorganic ion exchange agent ammonium phosphomolybdenum tungstic acid[57] and ammonium phosphototungstic acid paper.[58] The reverse phase paper layer analysis can also separate titanium, zirconium and thorium.[59] Paper layer analysis can separate gold from selenium, tellurium and precious metals.[60] This has already been used in separating gold and platinum family elements,[61] and trace amounts of gold in anodic clay can be directly determined.[62] Ions of five kinds of alkali metals[63] can be separated at once on the ammonium phosphomolybdic acid ion exchange paper using the water solution of ammonium nitrate and nitric acid as the expanding agents to expand the lower row. Electrolytic paper layer analysis can separate selenium and tellurium[64] and molybdenum and rhenium[65] which are difficult to separate. Studies have been conducted in paper layer analysis of various kinds of organic phosphorous compounds and paper electrophoretic separations, and the method of calculating the area of color spots has also been used in quantitative determination. The method of using electrodialysis via an ion exchange film to quantitatively determine uranium was proposed. It can also determine the reserve state of uranium in mineral ore.[66] Although laminar analysis is mostly used in organic analysis, it is also being applied in inorganic analysis. For example, reverse phase laminar analysis was used to separate niobium, tantalum and precious metals[67] and silica gel calcined plaster board laminar chromatography was used to separate selenium and tellurium.[68] The sensitivity of detection was in micrograms.

(V) Other Methods

Gas phase layer analysis is mostly used for organic matter, inorganic matter that does not easily evaporate must first be changed to metallic organic compounds that easily evaporate. Studies have been conducted in this regard, but reports have been few. At present, β-diketone is being studied. Fusion and concentration have mostly been used in assaying. Our nation has made many new achievements in this regard. For example, when using the lead assaying method to concentrate rhodium and iridium, platinum and gold are added to prevent loss of iridium and rhodium during blown ashing. Then an oxy-acetylene flame is used for high temperature burning so that the metallic compound granules blown ashed form platinum based rhodium and iridium alloys easily soluble in agua regia, thus solving the problem of low determination of iridium and rhodium by ordinary methods.[69] Separation of osmium and ruthenium can be done by direct distillation.[70] The ore sample is fused with sodium oxide. Then potassium permanganate is added, and osmium and ruthenium are distilled from the sulfuric acid solution. Hydrochloric acid, ethyl alcohol, sulfuric acid solution are used to absorb ruthenium and the sulfuric acid solution of arsenite is used to absorb osmium.

Some elements interfere with determination and they should be removed by separation but sometimes after adding a definite amount of related elements, the positive interference can reach a constant value. For example, when using the azonitrocarboxy photometric method to determine light rare earth elements in ores, the addition of a definite amount of yttrium can prevent the yttrium group of rare earth elements from causing interference.[71] Also, when using the flameless atomic absorption method to determine 15 kinds of rare earth elements in minerals, lanthium, cerium and yttrium will interfere with the determination positively and the addition of a definite quantity of interfering elements can produce good results.[72]

Complexometric Titrations

Aminocarboxyl complexing agents (such as aminotriacetic acid NTA, ethylenediaminetetra-acetic acid EDTA, cyclohexane-diaminetetra-acetic acid DCTA, ethylene glycol diethyl ether-diaminetetra-acetic acid EGTA etc) have a strong complexing ability with many metallic ions. In 1945, Xufachengbahe first proposed the use of EDTA to titrate calcium and magnesium and determine the hardness of water. Since then, a lot of work has been done in the study of the basic theory of complexometric titration (including chelating agents, metallic indicators, and theory and application of masking agents). Complexometric titration has thus become a new technique of volumetric analysis and plays a definite role in constant analysis. After founding of the People's Republic of China, our nation's scholars also studied complexometric titration. In the winter of 1959, the Chemistry Institute of the Chinese Academy of Sciences invited Professor Puxibi [phonetic] of Czechoslovakia to come to China to lecture, and the Chemistry Institute conducted a training class in complexometric titration. Afterwards, Liang Shuquan [2733 2885 2938] compiled and published Puxibi's lecture in the book "Complexometric Titration and Its Application." His lectures and laboratory techniques were recorded and new achievements and applications of new types of metallic indicators and masking agents were introduced. This promoted the development of this method in our nation. Inspection and coordination groups of many departments of our nation held training classes in complexometric titration and the method was popularized among basic level chemical laboratories.

Yan Zhixian [0917 1807 1720][1] was the earlier one to write about and introduce the theory concerning metallic indicators and the factors of color change. Chen Yongzhao [7115 3057 0340] also wrote several papers on the basic theory of complexometric titration and wrote comprehensive discussions such as the new developments in chelating agents,[2] metallic indicators and their development,[3] progress in chelatometric titration[4] and complexometric titration,[5] and comprehensively discussed progress in chelatometric titration of calcium.[6] Zhang Maosen [1728 2021 2773] also introduced the formula of the masking effect of chelation and its application.[7] These have served to promote the method of complexometric titration. Publication of such books as "theory and Application of Complexometric Titration" compiled by Yang Dejun [2799 1795 0193], "Aminocarboxyl Complexing Agent and Its Application in Analytical Chemistry" compiled by Chen Zhizhong [7115 1013 0022], "Application of Complexometric Titration in the Analysis of Mineral Raw Materials and Metals" compiled jointly by Sun Jexing [1327 4949 5281] et al, "The Method of Complexometric Titration" written by Xufachengbahe, translated by Ma Liren [7456 4539 0086] et al and edited by Liang Shuquan [2733 2885 2938], and "Application of Ethylenediaminetetra-acetic Acid in Analysis" written by Weierqie and translated by Liu Fuguan [0491 1381 1351] has helped the development of the method of complexometric titration among basic level units.

Masking Agents

There have been many reports domestically and abroad on increasing the selectivity of titration utilizing masking agents. Our nation's workers in analysis have also proposed some new masking agents. For example, lactic acid, glyceric acid and malic acid[8,9] all have a very strong complexing ability with tin (IV). In pH 5, they can mask tin and titrate lead or zinc. They can also use their replacement of EDTA in complex tin to titrate tin indirectly when lead, zinc, cadmium, copper, nickel, cobalt, iron and bismuth are all present. They can be used in rapid determination of tin in lead based or tin based alloys, or in continuous titration of lead, tin and copper.[10] They can also be used in replacement titration of tin in fine tin ore.[11] Some have proposed the use of gallic acid to mask tin.[12] Its function is similar to that of lactic acid, and it can be used for replacement titration of tin in alloys.

Lactic acid, glyceric acid and malic acid are also good masking agents of titanium (IV), in pH 5.5, they can mask titanium to titrate aluminum. Because lactic acid etc. can form weak complexes with aluminum, they can slowly replace EDTA in complex aluminum so that the end point can only be stabilized for about 20 seconds. They can also be used for replacement titration of titanium[13,14] in the presence of iron, small amounts of aluminum, zirconium, bismuth, lead, zinc, copper, cadmium, nickel, cobalt, antimony, arsenic, and the selectivity is relatively high. Some people have proposed that after using an appropriate amount of lactic acid to mask titanium, the use of DCTA back titration to determine aluminum can stabilize the end point.[15] Because the ability of DCTA to complex aluminum is stronger than EDTA, lactic acid will not replace the DCTA in complex aluminum.

Some have also used sodium hydroxide to precipitate and separate aluminum and then dissolve the hydroxides of iron and titanium and use the back titration method in pH 5 to determine the total amount of iron and titanium, and then use lactic acid to replace the EDTA of complex titanium and obtain the amount of titanium.[16] This shows that lactic acid has a good masking function for titanium.

It has already been discovered that amaric acid is a new masking agent[17] for titanium (IV). It is even better than lactic acid. It forms a stable complex with titanium and also does not mask aluminum. In pH 2.5 to 7.0, it can mask titanium. The use of amaric acid in pH 5 for replacement titration of titanium can allow large amounts of aluminum and over 10 types of heavy metals to coexist. For example, when used in pH 3 for replacement titration, thorium, cerium (III), lanthium and larger amounts of manganese cannot interfere. Amaric acid has been used to mask titanium and ammonium fluoride replacement has been used to rapidly titrate aluminum in alumina.[18] Amaric acid and fluorides can be used jointly for continuous titration of titanium, aluminum and iron[19] in alumina and silicates. Some have also used sulfosalicylic acid as an indicator in pH 2 to titrate iron using EDTA and then using amaric acid to continuously titrate[20] titanium and aluminum. The sensitivity and accuracy of the end point of this method is not as good as the previous method.

Tannic acid[21] can also be a masking agent for titanium, but the complexes are yellow, and over 1 gram of titanium will precipitate after boiling, therefore it can only be used to titrate aluminum when there is a small amount of titanium. Malic acid can mask tin and titanium and can also mask cerium (III) and light rare earth elements.[22] In pH 5.6, malic acid can replace EDTA that complexes rare earth. Using xylenol orange as an indicator, the EDTA released by lead photometric titration at a wavelength of 560nm can detect 40 to 500 micrograms of light rare earth, and large amounts of zirconium, iron, titanium (with hydrogen peroxide), bismuth, gallium, aluminum, niobium, mercury, copper, nickel, cobalt, zinc, cadmium, calcium, magnesium do not interfere. Only thorigum and manganese by extraction, the method can be used to determine rare earth in rare earth iron alloys.

Ammonium dithio-amino acetic acid (abbreviated TCA) and β-ammonium dithio propionic acid (β-DTCPA)[23] in pH 5 to pH 6 can mask lead, cadmium, mercury and small amounts of nickel and cobalt and titrate zinc, manganese or rare earth elements. In pH 2 to pH 3, they can mask bismuth, indium and thallium and titrate gallium, thorium or aluminum. The latter has a stronger complexing ability with lead and cadmium. Our nation's workers in analysis have used them to mask lead to titrate zinc and to solve the problems in complexometric titration of zinc without cyanogen. For example, TCA is used to mask lead and citric acid is used to mask small amounts of aluminum, thiocarbamide is used to mask copper, and zinc is directly titrated from the hot residual liquid of baked zinc sand[24]; or potassium fluoride is used to mask tin, iron and aluminum, thiocarbamide is used to reduce copper, TCA is used to mask lead and small amounts of cobalt and nickel to titrate zinc in copper alloys.[25] β-DTCPA has a stronger complexing ability with lead than TCA. Some have used it to mask lead to titrate zinc in tin bronze.[26,27] Others have also used β- DTCPA to replace EDTA to complex lead for indirect titration of lead.[27] There is also synthetic β-ammonium dithio-propionic acid. Its properties are similar to TCA and β-DTCPA, and it can also mask lead for titration of zinc in fine zinc ore.[28] Methyl glycine has been used to synthesize ammonium dithio-methyl acetic acid. The authors have not studied its masking property, but only its coloration property. It is suitable as a coloration agent for copper.[29] Its synthesis has been done abroad and it is believed that its properties are similar to those of TCA. In pH 2 to pH 3, it can mask indium to titrate gallium.[30]

Malonic acid of pH 5 to pH 6 can mask iron (III) and titrate lead.[31] But, it not only can mask iron, it can also mask aluminum and titanium,[32] but it does not mask tin, therefore, it is best suited for replacement titration of aluminum in the presence of tin. This is not possible using fluorides.

Some have also proposed the use of citric acid[33] of pH 10 or sodium hexa-m-phosphate[34] of pH 4.5 to replace fluorides in indirect titration of aluminum. Both can mask tin and titanium. When both are present, they must first be separated.

Titration Methods for Some Elements

Aluminum: Titanium, tin and manganese interfere with fluorides in replacement titration of aluminum. Besides the new masking agents proposed above, some have used copper reagents of pH 3.7 to precipitate the interfering elements. Copper and iron reagents are then added to the filtered solution to mask and precipitate incomplete titanium, then aluminum in the alloy is titrated by replacement in sodium fluoride of pH 5.5.[35] Some have also used copper reagent and phenylarsonic acid jointly in a pH 3 solution to precipitate and separate iron, titanium and nickel. Manganese (II) can form tertiary complex compounds which are difficult to dissolve with o-phenanthrene dinitride and sulfocyanate radicals and they can be filtered out together. Then xylenol orange is used as an indicator to determine aluminum in steel and iron[36] in a pH 3.5 solution by bismuth titration using ammonium fluoride to replace EDTA in complex aluminum. When performing a replacement titration of aluminum in a pH 5 solution, large amounts of calcium and phosphate radicals will interfere. If the concentration is changed to pH 3.5 and PAN is used as the indicator, the use of copper titration with sodium fluoride replacing the EDTA in complex aluminum can determine the aluminum in apacite, allowing the simultaneous presence of calcium and phosphorus five to six times the amount of aluminum.[37]

Continuous Titration of Iron, Aluminum, Titanium

It has been mentioned previously that amaric acid and fluorides can be used in continuous titration of titanium, aluminum and iron. But acidic effects can also be used. First, an excess amount of EDTA is used to complex iron, then hemixylenol orange is used as the indicator. In a pH 2 solution, bismuth salt is used to titrate the excess EDTA to obtain iron, then hydrogen peroxide and an excess amount of EDTA are added to complex titanium peroxide ions, then bismuth is used in a back titration to obtain titanium, and finally an excess amount of DCTA is added, stirred for half an hour, and then zinc is used in a solution of pH 5.7 in a back titration to obtain aluminum.[37] This method will yield relatively large errors when the content of aluminum or titanium is high.

Continuous Titration of Calcium, Magnesium, Iron and Aluminum

These four elements can be continuously titrated from silicate rock in the same solution.[39] First, iron and aluminum (titanium) are masked in a pH 10 solution using triethanolamine in the solution to separate silica. When using EDTA to titrate calcium and magnesium, the concentration is changed to pH 13, and the EDTA released from calcium titration of complex magnesium is weakened by hydrochloric acid. Then an excess amount of EDTA is added and the contents boiled at pH 5.9, after cooling, the excess EDTA is titrated by zinc titration, and potassium fluoride is used to replace EDTA of complex aluminum. Finally, ammonium fluoride and potassium fluoride are added to the amount of aluminum (titanium) obtained by zinc titration, the content is boiled so that iron forms K_3FeF_6 and precipitates and releases an equivalent amount of EDTA, then zinc titration is used to obtain iron. Because silicate rock contains very minute amounts of interfering heavy metals, this method is feasible.

Calcium, Magnesium

Complexometric titration of calcium and magnesium is fast and accurate to a definite degree. A lot of research work has already been done at home and abroad. Large amounts of manganese will interfere with titration of calcium and magnesium. Some have used triethanolamine to complex manganese. Air oxidizes the bivalent manganese to a trivalent complex compound and then potassium arsenide is added. The $Mn(CN)_6^{3-}$ thus formed is oxidized to $Mn(CN)_6^{3-}$ by hydrogen peroxide. At this time, the compound does not form a precipitate with calcium, thus after masking manganese, titration of calcium and magnesium in the manganese ore can be performed.[40] Some have used sodium peroxide fused with pyrolusite, and then ammonium persulfate is used in 0.2N sulfuric acid to oxidize manganese to form permanganate radicals. These undergo static exchange in the model 717 aniomic resin. The filtered solution is precipitated by hexamethylene tetramine and copper reagent to mask the remnant manganese and iron, aluminum, copper, nickel, lead and zinc, and titrate calcium and magnesium.[41] When titrating calcium in solution containing silicon, calcium silicate may possibly form, yielding a low result. The new potassium silicate formed by adding a small amount of potassium fluoride in the solution to form silicofluoride first and then by diluting and by alkalization is widely scattered and contains a lot of water and the surrounding is masked by water molecules, thus calcium silicate does not easily form to affect titration of calcium.[42] Our nation's workers in analysis wanted to avoid the use of potassium cyanide, so they used copper reagents to precipitate and separate interfering ions, and used triethanolamine to mask aluminum in the solution, then titrated calcium and magnesium. For example, this method was used in determining calcium[43] in residues of the reverberatory furnace and furnace materials and in titration of magnesium[44] in spheroidal graphite cast iron.

Some have used EGTA-Ba complex compounds to mask calcium and titrate magnesium[45] in rare earth silicon iron alloys. Citric acid and triethanolamine have been used in a pH 10 solution to mask rare earth, iron, aluminum and manganese, and then EGTA-Ba complex compounds are added. The Ba replaced by calcium is precipitated by sodium sulfate, and magnesium can be titrated by EDTA. After fusing iron ore, hexamethylene tetramine is used to precipitate iron, aluminum, titanium and vanadium, then a copper reagent is used in a pH 9 solution to precipitate copper, lead, zinc and manganese. Calcium in the filtered solution is titrated by EDTA, then the solution is changed to pH 10 and magnesium[46] is titrated by EDTA, or another preparation of the filtered solution is taken and EGTA is used to mask calcium and then titrate magnesium.[47]

Rare Earth

After the alloy is dissolved in acid, hexamethylene tetramine or a copper reagent is used in a pH 5.5 solution to precipitate iron, aluminum, titanium, thorium and manganese. Then, remnant iron and thorium in the filtered solution are masked by 2,4-pentadiketone. The total amount of rare earth[48] can be titrated by EDTA. If it is changed to DTPA for titration, the end point will be even more visible.[45] Some have also used hydrofluoric acid to precipitate rare earth, and after filtering, perchlorate is used to dissolve the content and 2,4-pentadiketone is used to mask the remnant iron etc to titrate rare earth.[49]

Copper, Zinc, Tin, Cadmium, Cobalt and Nickel

Unmasking by potassium cyanide-formaldehyde to titrate zinc is not welcomed. It has been mentioned previously that lead can be masked by using ammonium dithio-amino acetic acid or ammonium dithio-propionic acid, thus solving the problem of complexometric titration of zinc without cyanogen. In addition, some have utilized the fact that lead sulfate can form mixed crystals with barium sulfate to eliminate interference by lead. Then, potassium fluoride is used to mask tin, iron and aluminum, and thiocarbamide is used to mask copper, and zinc[50] in tin bronze can be titrated in a pH 5.5 solution. Similarly, lead can be utilized to form mixed crystals and to form the KF·MnF complex salt with manganese. This precipitates with K_3FeF_6 and eliminates their interference. After copper is reduced by thiocarbamide, zinc[51] in fine zinc ore can be titrated in a pH 6.7 solution. Some have used nitric acid to dissolve chalcopyrite, then used ammonium sulfate to oxidize iron, aluminum, titanium, tin, bismuth and chromium. Copper in the filtered solution is masked by sodium thiosulfate, zinc is titrated in a pH 5.5 solution, then the concentration is changed to pH 10 and ammonium persulfate is used to oxidize copper to bivalent and copper is titrated[52] using EDTA. Some have used acids to dissolve copper alloys, and used potassium fluoride to mask tin and aluminum, then EDTA is used to quantitatively complex other cations, and then copper is reduced to monovalent in a pH 5.5 solution by thiocarbamide, ascorbic acid and a small amount of amino thiocarbamide, the EDTA released undergoes lead titration to obtain copper.[53]

Besides titrating tin using the above mentioned lactic acid to replace the EDTA in complex tin for indirect titration, the method of ammonium fluoride replacement is frequently used. But this method is interfered by aluminum. If the alloy does not contain a lot of aluminum, 2,4-pentadiketone can be used for masking.[54]

It is rather difficult to titrate cadmium in the presence of zinc. In titrating trace amounts of cadmium[55] from zinc ore, some have used citric acid to mask iron, and used sodium sulfide to precipitate zinc, cadmium, copper, tin, and the sulfides filtered out are dissolved in hydrochloric acid, and under strong alkalines and glycerine, cadmium becomes hydroxides and is precipitated and separated from zinc and copper. Then an acid is used to dissolve cadmium hydroxide and titration can be done using EDTA.

After nickel in alloy steel is dissolved in perchlorate, chromium oxide becomes hexavalent. In a solution of pH 12.5, triethanolamine is used to mask iron, aluminum, titanium and small amounts of copper and manganese. An excess amount of EDTA is then added, and calcium yellow green and phenolphthalein complexing agents are used as indicators, and calcium is used in a back titration to detect 8 to 34 percent of nickel contained in steel.[56A] Mercapto-acetic acid can also be used to mask copper, tin, lead, zinc, bismuth, cadmium, and triethanolamine can be used to mask iron and aluminum. An excess amount of EDTA is added and calcium back titration is used to determine nickel in bronze.[56B]

In the analysis of cobalt and nickel in cobalt residues, N-235 sulfonated kerosene in an 8N hydrochloric acid can extract chloride complex anions of cobalt, copper, iron and zinc and separate them from nickel. Three extracted solutions are taken and 2N sodium chloride is used for reverse extraction of cobalt. Thiocarbamide and triethanolamine are then used to mask copper and iron. In a pH 10 solution, ammonium violurate is used as an indicator and EDTA is used to titrate cobalt. The nickel in the liquid phase is neutralized by ammonia water and then titrated in a pH 10 solution.[57]

Zirconium and Hafnium

Zirconium (hafnium) can be titrated under strong acids and the selectivity is high. Zirconium in zircon should be titrated in 1.5 to 1.75 N nitric acid using xylenol orange as the indicator. The titration is performed after boiling the content. Only tin (IV) will cause interference.[58] Some believe zirconium can be titrated at 90°C in 1 to 2 N hydrochloric acid.[59] The zirconium ion easily polymerizes. When the zirconium solution is changed to 3 to 5 N by hydrochloric acid, then by adding 10 times the amount of sulfate radicals, boiling for 1 to 2 minutes and diluting to 0.6 to 0.8 N acidity, the zirconium ions will depolymerize and zirconium can be titrated in room temperature.[60] The amount of zirconium and hafnium can be determined by the weighing method and by complexometric titration. First, amaric acid is used to precipitate zirconium and hafnium. These are then heated to become dioxides, then they are weighed. Zirconium dioxide and hafnium dioxide are then fused in potassium pyrosulfate, and dissolved in sulfuric acid and precipitated by ammonia water, filtered, dissolved in hydrochloric acid and back titrated by iron in a pH 4 solution after adding an excessive amount of EDTA. The combined amount of zirconium and hafnium can be calculated. The weights of zirconium and hafnium[61] can be obtained by solving the simultaneous equations using the two weights obtained earlier.

Platinum

Quadrivalent platinum in the absence of acetate radicals and nitrate radicals can complex with EDTA in a 1:1 ratio after boiling in a pH 3 to pH 4.5 solution. The ordinary amount of platinum[62] in the intermediate products produced in metallurgical process of precious metals can be determined.[62] Ammonium chloride is used to precipitate platinum into $(NH_4)_2$ $PtCl_6$, the solution is filtered, dissolved by ammonia water, and an excess of EDTA is added, boiled slightly for 20 minutes, and zinc is used to titrate the excess EDTA to obtain platinum, palladium, gold and silver, and small amounts of rhodium and iridium, copper, nickel will not interfere.

Bismuth and Phosphate Radicals

Bismuth and EDTA complex in a relatively stable fashion and bismuth can be titrated under relatively strong acidity. Zirconium, tin, thorium, niobium and tantalum can be masked by fluorides and antimony can be masked by tartaric acid. Iron and vanadium can be reduced by ascorbic acid to eliminate their interference. Some believe it is better to titrate in a pH 1 solution using the mixed PAR-thiocarbamide indicator.[63] After the bismuth in alloys which can be easily melted is dissolved, ascorbic acid is used to reduce iron, and tartaric acid is used to mask tin, thiocarbamide is used to mask copper, and bismuth can be titrated using EDTA.[64] The heavy metallic ions of trace amounts of bismuth in tungsten ore can be complexed using citric acid and potassium cyanide. The concentration of the solution is changed to pH 9 to pH 11 and carbon tetrachloride can be used to extract the complex compounds of bismuth-copper reagents, and 1:1 nitric acid is used for reverse extraction, and bismuth can be titrated under 70°C using thiocarbamide as the indicator in a pH 1.5 solution.[65]

Using bismuth to precipitate phosphate radicals to become bismuth phosphate for indirect titration is better than using precipitation to form magnesium phosphate. The phosphorus in phosphorous ore or phosphorous fertilizers,[66,67] and in ferrophosphorus or phosphocopper[68] can be dissolved by nitric acid and the sulfate radicals and chlorine ions can be eliminated by distillation. The phosphate radicals are precipitated by 2.5 times of bismuth in 0.4 to 0.5 N nitric acid solution, aged for 30 minutes, and ethyl alcohol is added to reduce solubility and chloroform is used (some use nitrobenzene[69]) to cover the surface of the precipitate to reduce adsorption. The remnant bismuth is titrated by EDTA in a pH 1.2 solution and the amount of phosphorus is calculated. Iron is reduced by ascorbic acid. When the amount of aluminum is not greater than the amount of phosphorus, there is no interference.

Tungsten

Tungsten complexes extremely weakly with EDTA and this can only be used in indirect titration. Some have used acids to dissolve tungsten ore and then used sodium hydroxide to dissolve the tungstic acid thus obtained. The tungstate radical is precipitated by barium chloride in a pH 7.2 to pH 8.0 solution. After setting aside, a part of the clear solution is taken and changed to pH 10, and the remnant barium is titrated using EDTA.[70] The interfering ions in ferrotungsten can be precipitated and separated by sodium hydroxide, and the tungstate radical can be precipitated in a pH 4.5 solution by lead, then 2,4-pentadiketone, o-phenanthrene dinitride and lactic acid can be used to mask the remnant iron, aluminum, tin, copper and manganese. Tungsten[71] can then be obtained by titrating the excess lead in a pH 5.5 solution. In recent years, many units have been studying direct titration of the excess lead in the precipitated tungstate radical in weak acidic solutions, but tungsten ore contains a lot of impurities, interference is serious, and until now a reliable method has not been obtained.

Utilizing Ammonia Triacetic Acid as a Titrating Agent

The ability of NTA to complex metallic ions is weaker than EDTA. In a pH 5.2 solution in which copper, lead, zinc, cobalt, nickel, cadmium and manganese are present, only Cu-NTA complex compounds manifest a stability constant greater than 10^7. Titration of copper using NTA allows the presence of manganese, small amounts of cadmium, cobalt, zinc, nickel and lead. When there is a lot of lead present, sodium sulfate can be used, aluminum and tin can be masked by sodium fluoride, and this method can be used directly to titrate copper in bronze.[72] It is impossible to use EDTA. NTA can also be used to titrate niobium[73] in alloys of niobium, nickel and zirconium. An excess amount of NTA is added to a pH 5.6 solution with the presence of hydrogen peroxide, violurate amine is used as the indicator and copper is used in back titration. Zirconium, titanium, tin and tungsten are masked by fluorides, allowing the presence of small amounts of manganese, tantalum, vanadium, uranium, cerium (III).

Titration of Trace Amounts

Titration of trace amounts is done in a 30 or 50 milliliter porcelain crucible as the container. EDTA solution of 1 to 0.1 mM of small volume (5 to 10 milliliters) is used for titration of trace amounts of some elements. For example, rare earth elements of 50 to 400 micrograms in a pH 5 solution were titrated and 12 kinds of indicators were compared. It is believed that xylenol orange, methyl phenol blue and 4-(2'-thiazolyl azo) and resorcin are the best. Lead, bismuth and mercury can be masked by dimercaptopropyl alcohol. Copper, cobalt, nickel, zinc and manganese can be masked by o-phenanthrene dinitride, iron can be reduced by hydroxyl ammonia, and tungsten, molybdenum, and chromium will not interfere with the titration.[74]

Some have also performed titration of 5 to 500 micrograms of thorium,[75] studied 16 kinds of indicators, and xylenol orange, azo arsine, methyl phenol blue changed colors most sensitively in a pH 2 to pH 4 solution. The error was the smallest, and the interference by scandium can be extracted, separated and eliminated using ammonium sulfocyanic acid ethyl ether.

In 0.5 to 2.2 N hydrochloric acid, 5 to 400 micrograms of zirconium are heated and boiled. Xylenol orange or methyl phenol blue is used as the indicator, and 0.2mM of EDTA can be used for titration. Iron is reduced by hydroxyl ammonia. Five milligrams of other elements of copper, manganese, aluminum, rare earth, bismuth, chromium, molybdenum and uranium are allowed to be present, and 10 milligrams of titanium and thorium are allowed to be present, and small amounts of tin, vanadium and tungsten will not cause interference.[76]

Some have compared nine kinds of indicators for titration of 3 to 300 micrograms of thallium (III).[77] PAR and PAN are the most sensitive in indicating the end point. Titrating in a pH 1 to pH 2 solution, lead, cobalt, chromium, zinc, cadmium and small amounts of iron and aluminum (masked by ammonium fluoride) will not interfere.

Scandium and other light rare earth elements can be continuously titrated.[78] First titrate 1 to 400 micrograms of scandium using 0.05mM of EDTA and xylenol orange as the indicator in a solution of pH 1.8 to pH 2.2. Then titrate light rare earth 5 to 1,000 times the amount of scandium in a solution of pH 5.0 to pH 5.5 (using 0.001M of EDTA). The error of titration of scandium and rare earth is both 0.1 percent. Titrating scandium can be done in the presence of iron and tin (reduced by hydroxyl ammonia), copper (reduced by thiocarbamide) and light rare earth, mercury, chromium, lead and zinc.

Using photometry to determine the end point can increase the sensitivity of the method. Rare earth elements[79] of 3 to 10 micrograms can be photometrically titrated using 0.1mM of EDTA in a solution of pH 5.5 and under a wavelength of 660nm and azo arsine (III) as the indicator.

Dimming of equivalent points E_{eq} is calculated by the Linpang (?) formula, thus obtaining the amount of rare earth. Using the DDTC-chloroform method of extraction can eliminate the interference of many elements. The remnant aluminum can be masked by sulfosalicylic acid.

Photometric Analysis

During these festive days of celebrating the 30th anniversary of the founding of the People's Republic of China, reviewing our nation's work in photometric analysis is meaningful to the understanding and development in analytical chemistry in our nation and further expanding our nation's work in analytical chemistry to better serve the "four modernizations."

There has already been a good description[1] of chemical analysis for the 10 years following the founding of the nation, including the situation in photometric analysis. Therefore, this article will give an overall introduction to the work related to photometric analysis after 1960.

Because the conditions required in photometric analysis are relatively simple and easily grasped, therefore it is one method that has developed the earliest after the founding of the nation. In particular the domestically manufactured 72 model, 721 model and 751 model spectrophotometers and the continuous successful test production and development of various organic reagents for analysis have established the foundation for effectively expanding photometric research in our nation. Preliminary statistics show that at present, there are already over 100 kinds of organic coloration reagents being used in photometric analysis in our nation.

The number of people engaged in photometric analysis in our nation outnumbers those engaged in any analytical method. It is an important team in analytical chemistry that has a large number of people and a strong force and is spread out throughout the nation. The team has contributed greatly in coordinating with the establishment of such basic industries as steel and mineral exploration and the silicate industry and acid and alkaline industry, as well as in the development of such new materials as atomic energy materials and semiconductor materials and environmental protection during the period of economic construction. The workers have also gained practice, elevated the standard and developed their team.

Analytical chemistry also suffered from interference and sabotage by the "gang of four in our nation. A lot of time was wasted, but with the efforts of the broad masses of workers in analysis, a lot of work has been done. In photometric analysis alone, over 30 comprehensive papers have been published. Organic reagents used in photometric analysis,[2-15] progress in photometric methods of individual elements,[16-25] instruments used,[26] some new methods and basic problems[16-27-36] in photometry have all been introduced. Nearly 600 articles on photometry have been published. The standard of the work reached still lags behind the advanced international levels by a definite distance. There has been few creative work, there is still a lot of research work that awaits our development, but this distance is not great. We deeply believe that after several years of efforts and struggle, we can definitely catch up with the internationally advanced levels.

In recent years, although various methods of analysis by instruments have emerged, statistics of the articles in analytical chemistry published in the several specialized publications show that photometry constituted about 45 percent of the entire body of analytical methods at the beginning of the 1960s. During the past 7 years, this has remained stable at 30 percent. Therefore, photometric analysis has not lost its importance, like the other analytical methods, it will continue to serve importantly in the construction of our nation's "four modernizations."

Because a lot of work is being done in photometric analysis throughout the entire nation, there are many internal publications and information and it is difficult to collect all of them, therefore the publications that are published for the general public have been used as the main source for describing the situation in photometric analysis in our nation during the past 20 years. The subject is divided into the following topics and briefly described.

I. Application of Several Kinds of Sensitive Coloration Agents

(I) Pyridine azo compounds

1. 1-(2-pyridine-azo)-2-naphthol (PAN):

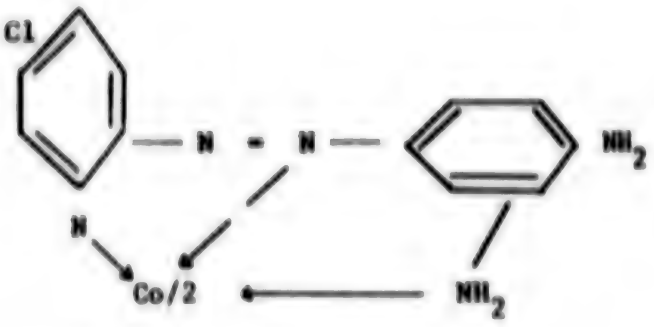
He Lishu [0149 4539 2579] et al used PAN to establish the photometric method of extracting mercury,[37] and direct photometric method[38] and photometric method for antimony.[39] In the extraction method, the most suitable concentration of chloroform for extracting complex compounds is pH 7.5 to pH 11.3, λ_{max} = 555 millimicrometers, $\epsilon_{555} = 1 \times 10^4$, the composition of the complex compounds is Hg:PAN = 1:1. Direct photometric method is carried out in a water-ethyl alcohol solution, the suitable colorimetric acidity is pH 6.5 to pH 8.3, λ_{max} = 555 millimicrometers, the 0 to 125 microgram mercury/50 milliliter satisfies Beer's Law. Antimony forms a triple complex compound in a strong acid medium Sb(III) with KI and PAN and it can be extracted and determined photometrically. The extraction acidity is 0.5 to 1.5 N H_2SO_4, λ_{max} = 570 millimicrometer, $\epsilon_{570} = 1.56 \times 10^4$. The Chengdu Electrometallurgical Plant[40] used PAN for coloration in a pH 9 to pH 10 solution and determined zinc in metallic nickel and cobalt. The results show the accuracy and repetitiveness of the method are both good.

2. 4-(2-pyridine azo) resorcin (PAR):

Wang Shunrong [3769 7311 2837][41] more systematically studied the composition of the complex compounds formed by rare earth elements and PAR and the possibility of using them in photometric analysis. The results show PAR is the least sensitive to lanthium and most sensitive to yttrium. It can detect yttrium in a pH 8.1 solution. Li Jiechun [2621 5354 2504] et al[42] explored the effects of PAR and PAR-H_2O_2 on titanium and pointed out both can form colored complex compounds. Ti-Par is a red complex compound, the greatest absorption peak is at 250 millimicrometers, the suitable coloration acidity is 7.5 to 8.3, the range of determination is 0 to 1.5 microgram microliter, Ti:PAR = 1.2. In the presence of H_2O_2, PAR and titanium form an orange red complex compound, the greatest absorption peak shifts to 510 millimicrometers, the suitable coloration pH is 7.8 to 8.5, the range of detection is 0 to 1.5 microgram/microliter. In addition, there is also the method of ion exchange to separate niobium and using PAR to determine niobium in alloy steel,[43] as well as directly determining 0.01 to 1 percent of niobium in steel.[44] There are also methods to detect lead[45] in chalcopyrite using PAR in a pH 10 solution and KCN to mask copper, zinc, nickel, cobalt, mercury, bismuth, cadmium and manganese. PAR can detect lead of less than 1 percent in tin based alloys with acetic acid serving to mask interfering elements.[46] Ji Zhihui [1373 1807 6540][47] extracted gallium in 6N HCl medium using ethyl acetate and PAR for coloration in a pH 6 to pH 7 solution after reverse extraction, and determined gallium of 10^{-4} percent in minerals by masking Nb(V), scandium (III) and tin (IV) with H_2O_2 tartaric acid. Zhang Quanfang [1728 0356 5364][48] used the PAR-H_2O_2 method to directly determine vanadium in rutile in the presence of NH_4F in a solution of 0.72 N acidity.

3. 4-((5-chloro-2-tantalum pyridine) azo)-1, 3-diaminobenzene (5-Cl-PADAB) and 2-(5-Bromine-2-azo-pyridine)-5-diethyl amino phenol (5-Br-PADAP):

The Department of Chemistry[49] of Beijing University conducted experiments in the conditions for determining cobalt using 5-Cl-PADAB and the composition of complex compounds. They show that the composition of the complex compounds is Co: reagent = 1.2 According to infrared spectral analysis, 5-Cl-PADAB is a triple coordinate basic chelating agent. The structure of the chelate formed by it with cobalt may be:



The method has successfully been applied to the determination of cobalt in steel alloy and ordinary carbon steel. Sun Linggao [1327 7881 7559][50] used 5-Cl-PADAB to conduct an experiment in the method of analysis of cobalt in ores and showed that the complex compounds have a λ_{max} = 570 millimicrometers, $\epsilon_{570} = 1.03 \times 10^5$, and under room temperature, the complex compounds are formed quantitatively in pH 4.5 to pH 7.5. The interference from iron is masked by sodium pyrophosphate. Using the boiling water bath to heat for 2 minutes can increase the allowable amounts of nickel and copper to 2 milligrams and 4 milligrams. Wu Guisheng [0702 2710 3932] et al[51] used 5-Cl-PADAB in the determination of cobalt in iron and steel. The interference by iron was eliminated by Zn-EDTA. The interference from a large quantity of chromium was eliminated by evaporation of Hcl-$HClO_4$. This method was used to analyze many types of standard steel samples, and the results and the standard values were consistent. Bu Weihong [0592 5898 4767][52] used this reagent in the determination of palladium and showed the violet complex compound formed by 5-Cl-PADAB and palladium can be extracted by n-pentanol, λ_{max} = 594 millimicrometers, $\epsilon_{594} = 5.5 \times 10^4$, the composition of the complex compound is Pd:5-Cl-PADAB = 1:1, the composition of the extracted complex compound is $(Pd \cdot 5\text{-}Cl\text{-}PADAB \cdot 3n\text{-}AmOH)^{2+} \cdot 2Cl^-$, the instability constant is 2×10^{-7}. The selectivity of the method is good. It is used in the determination of palladium in anodic clay catalysts and in the presence of platinum group elements.

Gao Jianli [7559 1696 0500] et al[53] studied the use of 5-Br-PADAP to determine antimony. Hu Zhide [5170 0037 1795] et al[54] studied the method to determine copper and showed that in a solution of pH 3 to pH 6, copper and the reagent form 1:1 complex compounds which can be extracted by chloroform, λ_{max} = 552 millimicrometer, $\epsilon_{552} = 5.3 \times 10^4$, the interference from iron is masked by NH_4F, alkaline metals and alkaline earth metals do not interfere, and the method is used in determining copper in lead, cadmium, magnesium, table salt, tap water and hair.

(II) Diaryl Azo Compounds of Allochromatic Acids

1. Azonitrocarboxylate:

The Department of Chemistry[55] of Wuhan University was the first in our nation to synthesize azonitrocarboxylate and used it to study coloration reaction with rare earth elements. A new method of determining rare earth of the cerium group directly by photometry in the presence of yttrium group rare earth without separation was proposed. BMBP was also used to extract and separate the interfering elements, and the total amount of rare earth was determined by the use of azoarsine II, azonitrocarboxylate was used to determine the component amounts of rare earth in the cerium group. It was also applied in the determination of the total amount of rare earth in such ores as phosphoyttrium ore containing 0.0X to X percent of rare earth and the component amounts of rare earth in the cerium group. The method is simple, quick, and repetitiveness is good. The experiments showed that the greatest absorption of complex compounds of lanthium in a 1.4 N acetic acid medium is at 730 millimicrometers. At this time, the reagent is almost completely absorbed. The four elements of La, Ce, Pr, Nd are all within the range of 0 to 25 microgram/25 milliliter, satisfying Beer's Law. Under this condition, other rare earth elements after samarium almost do not undergo coloration. Later, Wuhan University, Guangdong Nonferrous Metals Institute, Guangdong Metallurgical and Geological Institute[56] used ion exchange and ammonia water to precipitate and separate the interfering elements, and used azoarsine III to determine the component amounts of rare earth of the cerium group (La, Ce, Pr, Nd), and after production and practice in analyzing several hundred ore samples, the method was proven to be reliable. They[57] also established the method of using EDTA to suppress rare earth elements of the yttrium group in a formic acid medium, using PMBP for extraction-formic acid reverse extraction of rare earth elements, and using continuous photometry to determine the total amount of rare earth (azoarsine III method) and rare earth elements of the cerium group (azonitrocarboxyl method). These methods were used in determining the rare earth elements of 0.01 to 1 percent of the cerium group in monacite, phosphoyttrium ore, and black tungsten ore. The Tianjin Metallurgical Geological Survey Institute[58] used EDTA-Zn to eliminate the interference from heavy rare earth, used azonitrocarboxylate to determine the amount of light rare earth, and obtained the content of heavy rare earth in the ore by subtracting the amount of light rare earth from the total amount of rare earth.

2. Azoarsine III: Azoarsine III is one of the coloration agents most used in our nation. It is widely used in determining the total amount of rare earth in steel and iron, ore, and nonferrous metals, determining thorium, uranium, scandium in ores and rocks, and determining zirconium, titanium and calcium in ores and nonferrous metals. Zeng Xianjin [2582 2009 3160] et al[59] pointed out that the complex compounds of rare earth elements and azoarsine III can be extracted by normal butyl alcohol in the presence of diphenylguanidine. The sensitivity is onefold higher than that in water phase colorimetry. The molecular absorption coefficient of cerium is the smallest at 104,000 and that of yttrium is the greatest at 133,000. Feng Jiaji [7458 1367 4480] et al[60] used EDTA to complex calcium without extraction in a trimonoethanolamine alkaline medium and used magnesium as the carrier body to precipitate rare earth, then determined the total amount of rare earth in ores using the azoarsine III colorimetry in the presence of ascorbic acid, sulfosalicylic acid and sodium dihydrophosphoric acid. The Zhehiang Machinery Institute[61] used EDTA to mask iron and directly used azoarsine III to determine the total amount of 0.01 to 0.1 percent rare earth in spheroidal iron. Zhang Jiaowu [1728 2403 2524][62] separated titanium by heating and boiling a strongly alkaline solution with trimonoethanolamine and H_2O_2 added simultaneously to eliminate interference by phosphorus and titanium present together in the determination of the total amount

of rare earth in apatite. Lai Wenming [6351 2429 2494] et al[63] established the method of using an acetic acid sodium-copper reagent to separate azonitroarsine III colorimetry in a pH 5 to pH 9 solution to determine 10^{-2} to 3 percent of calcium oxide in rocks, iron ore, clay, copper ore and nickel ore and using acetyl acetone to mask the interfering elements. Qin Guangrong [4440 0342 2837] et al[64] used PMBP to extract uranium, thorium and rare earth in the presence of tartaric acid, H_2O_2, and sulfosalicylic acid. Then he used 3 percent HCl for reverse extraction of uranium, 4N HCl for reverse extraction of thorium, and azoarsine III colorimetry to determine uranium and thorium in niobium and tantalum ore.

3. Azochlorophosphine I: Azochlorophosphine I is used abroad for determining uranium and protactinium etc. In our nation, Liu Hengchuan [0491 1854 2796] et al[65] synthesized that reagent and believed it is a hopeful coloration agent for determining magnesium. The Machinery Manufacturing Technology Research Institute of Shanghai and the Shanghai Diesel Engine Plant[66] used this reagent to study the method of determination of magnesium. They showed that its sensitivity is only less than the most sensitive method of dimethylaniline blue I-colloidal bundles to increase solubility for determining magnesium. The selectivity is better and it is used in the determination of magnesium in aluminum and zinc alloys. The coloration acidity is pH 10, the determination wavelength should be selected at 580 millimicrometers where absorption of the reagent is small. Iron does not interfere. Aluminum is masked by trimonoethanolamine. Zinc, manganese and nickel are masked by phthalein, rare earth and calcium are masked by ethylene glycol diethylether diamine tetra-acetic acid (EGTA)-Pb. Copper is masked by tetraethylene pentamine. Xiao Mantian [5135 3341 3944][67] used this reagent to establish a direct method of determining magnesium in rare earth spheroidal iron that is similar to the abovementioned method. He also pointed out that the composition of the complex compound is Mg: reagent = 1.1, $\varepsilon_{576} = 1.85 \times 10^4$. This method is simpler in operation than the method of using dimethylaniline blue I and collidal bundles to increase solubility. The selectivity, stability and repetitiveness are good.

4. Azochlorophosphine III: Because azochlorophosphine III has a stronger salifying radical ($-PO_3H_2$) and electron absorbing radical ($-Cl$), which can produce coloration with some metallic ions in a stronger acidic medium. This has provided a more superior condition than azoarsine III for determination without separation. Xiong Xiaoxian [3574 1321 0341][68] used this reagent to directly determine uranium in seawater. Pan Jiaomai [3382 2403 7796][69] caused the reagent to react with UO_2^{2+} in a 3N HNO_3 medium, thus increasing selectivity. It is used in the determination of uranium in some adsorption agents and deadsorption fluids. More work is being done using this reagent to study and determine the total amount of rare earth in spheroidal graphite cast iron. For example, Liu Shaopu [0491 4801 3877] established the method[70] of determining the total amount of rare earth in spheroidal iron and some alloy steels directly in the presence of definite amounts of EDTA and ascorbic acid, as well as the method[71] of determining the total amount of rare earth in steel and spheroidal iron with the use of normal butyl alcohol of between pH 1.05 and pH 1.10 to extract rare earth azochlorophosphine III complex compounds. The sensitivity is increased fourfold compared to that in water phase colorimetry. The Yongkang

Tractor Plant et al[72] used EDTA, NTA, oxalic acid to mask Fe^{3+}, Ti^{4+}, V^{5+}, Al^{3+}, Ca^{2+}, Th^{4+}, and H_2O_2 and amaric acid were used to eliminate interference from higher contents of titanium, and pure ethyl alcohol was used to increase the sensitivity of the method, H_2O_2 was used to increase stability, and the method was used for determining the total amount of rare earth in low alloy steel and ordinary alloys of spheroidal iron, copper, molybdenum, vanadium, titanium, and such alloys of spheroidal iron. Similar work includes the use of EDTA,[73] oxalid acid[74,75] or EDTA, amaric acid, H_2O_2 etc[76] as masking agents to directly determine the total amounts of rare earth in spheroidal iron and low alloy steel.

(III) Triphenyl Methane Dyes

1. Chromazurime S: The Suhan Boiler Plant[77] and the Qishuyan Motor Vehicle Plant[78] used chromazurines to directly determine aluminum in steel and iron in a pH 5.0 to pH 6.2 solution with ascorbic acid added to eliminate interference from iron. There were no interferences from 1 percent titanium, 2 percent vanadium, and 4 percent chromium. The Shanghai Turbogenerator Plant[79] used MIBK-benzoyl phenyl hydroxylamine to extract and separate titanium, iron, vanadium, and then used chromazurines to directly determine aluminum in iron based and nickel based high temperature alloy steel and ordinary steel, and high and low alloy steel. The Daye Steel Plant et al[80] proposed the use of EDTA-Zn to mask iron, mannitol to mask titanium and to determine aluminum in alloy steel directly. The Shanghai Materials Institute[81] used thiocarbamide and ascorbic acid to mask copper and iron to determine aluminum chalcopyrite. Tue Fushun Steel Plant[82] and Wu Guisheng [0702 2710 3932][83] separately used DDTC-phenylarsonic acid to precipitate and separate most of the metallic ions, and used copper and iron reagents to extract and separate titanium, vanadium, iron, zirconium, niobium and tantalum, and then used chromazurine S to determine aluminum in steel. The Jinzhao Iron Alloy Plant[84] used EDTA to mask iron and chromazurine S to determine aluminum in high vanadium iron. At this time, the pentavalent vanadium does not interfere. Tan Rangmin [6223 6245 3046][85] similarly used Zn-EDTA to mask iron, H_2O_2-Zn-EDTA to mask titanium, and directly determined aluminum in steel. The Northwest Copper Processing Plant[86] carried out coloration in a pH 9 to pH 10 solution and overcame the slow speed of complexing aluminum and EDTA and the greater effects of titanium and iron. It established the chromazurine S colorimetric method to directly determine beryllium in beryllium bronze.

2. Xylenol Orange: The use of xylenol orange as a coloration agent had already been studied and used in our nation at the beginning of the 1960's, for example, analysis[87] of zirconium in steel and iron, analysis[88] of thorium in monacite, indirect determination of fluorine,[89] determination[90] of bismuth in aluminum and aluminum alloys, and the use of xylenol orange to study scandium,[91,92] and methods of analysis of copper[93] and lead.[94] Others followed with the use of ethyl ether to extract iron, use of 1,2-cyclohexane diamine tetra-acetic acid (ECTA) to mask remnant titanium, zirconium, niobium, aluminum, manganese in the determination[95,96] of vanadium in alloy steel and pig iron and determination[97] of zinc in magnesium alloys. Ren Hao [0117 3493] et al[98] first used antipyryl methane for extraction and separation and then used xylenol orange colorimetric method to determine zinc in aluminum alloys. Dong Huiying [5516 1920 5391][99]

used agua regia to oxidize monovalent thallium to trivalent thallium, and xylenol orange method to analyze thallous iodide down to 1 microgram in the air. Li Kuanliang [2621 1401 0081][100] used H_2SO_4 - K_2SO_4 to make lead form a complex salt and precipitate it and separate it from other elements. The precipitate is dissolved in ammonium acetic acid, and then, hexamethylene tetramine is used as the buffer solution, and xylenol orange and hemixylenol orange coloration are used to determine trace amounts of lead in copper alloys. Ye Fuhua [5509 1381 5478] et al[101] used the xylenol orange method to determine hafnium in zircon. To mask the zirconium, the amount of Na_2SO_4 was increased, the amount of H_2O_2 was reduced, and Na_2SO_4 was added before adding H_2O_2. Under the conditions of determining hafnium, the presence of zirconium several times the amount of hafnium is allowed. The Chongqing General Machinery Plant[102] directly determined zirconium in cast aluminum in a 0.5N HCl medium. But SO_4^{2-}, F^-, PO_4^{3-}, tartaric acid radical, citric acid radical cause interference. When ascorbic acid is present, copper, manganese, iron, titanium, nickel and zinc will not interfere. Huang Haoxin [7806 3185 2450] et al[103] established the method of extracting and separating zirconium using PMBP in an HNO_3 medium, and determined zirconium in a heated uranium solution containing aluminum, iron, plutonium, neptunium, thorium and fluorine ions directly in an organic phase using xylenol orange colorimetry. Hu Qidao [5170 0796 6670][104] determined calcium by masking magnesium with 8-hydroxyquinoline in a pH 10.8 solution, and used EDTA to mask calcium to determine magnesium. Chen Han [7115 2194] et al[105] used a copper and iron reagent to separate interfering elements, added sodium tungstate to eliminate the effects of titanium and zirconium and used the xylenol orange method to determine aluminum in steel and alloys. Wu Jizu [0702 4949 4371][106] used ascorbic acid to reduce iron and eliminate interference. Excessive amounts of F^- are masked by $AlCl_3$. Zirconium is masked by diaminocyclohexane tetra-acetic acid, and niobium in steel is determined. Zhou Nan [0719 0589][107] used lanthium as the carrier in an HNO_3 medium, ammonia water for precipitation to separate bismuth, iron and silver, then used β-acetyl acetone to extract iron and bismuth and separate them, and determined bismuth in pure nitrate radicals.

IV. Organic Alkaline Dyes

1. Peacock green: Xu Shengjie [6079 3932 2638][108] used a mixed solvent of chlorobenzene-CCl_4 as a benzene subsitute, established the extraction and colorimetric method of gallium using peacock green, and increased ε_{630} millimicrometer = 61,700 to ε_{635} millimicrometer = 99,000. Wang Yubin [3769 3022 6333] et al[109] used butyl acetate to extract and separate gallium, used water for reverse extraction and used peacock green for coloration, and established the colorimetric method of determining gallium in highly pure aluminum. The Guangdong Provincial Geological Bureau[110] established the method of using benzene to extract complex compounds of Ta-peacock green to determine tantalum of several parts per millionth to several tens per hundredth in ores. Wu Ruilin [0702 3843 7207][111] established the method of using peacock green for colorimetric determination of gold by separating gold extracted by ethyl ether and elements of the platinum group to determine gold in pure metals of the platinum group and their alloys. At this time, NH_4Cl can be used to mask platinum. Zhu Yinquan [2612 4134 2936][112] established the method of determining gold in coarse copper using peacock green-toluene for extraction and

using nitric acid to dissolve coarse copper, so that the gold is concentrated in the residue and then agua regia is used to dissolve the gold. Hu Zhide [5170 0037 1795] et al[113] used peacock green to study the method of analyzing thallium. Benzene was used for extraction to form $TlCl_6 \cdot R^+$ complex compound · $\varepsilon = 8.4 \times 10^4$. The method was used in the analysis of thallium in indium, cadmium, ash etc and the results were good. Yan Fenyang [2518 1164 2254] et al[114] used toluene to extract $Zn\text{-}CNS^-$ - peacock green tertiary ion associates to determine zinc in electrolytic nickel solution. Lead, calcium, manganese bismuth, magnesium, antimony and aluminum under 200 micrograms will not interfere. The interference due to Co^{2+}, Fe^{2+}, Cu^{2+} can be masked by nitroso red, ammonium citric acid and thiocarbamide. In addition, there are methods using peacock green to determine antimony[115] in chalcopyrite and boron[116] in steel.

2. Crystal violet: Guo Jingnan [6753 4552 0589] et al[117] studied the use of the tertiary system of Mo(V)-CNS-crystal violet to determine molybdenum and showed that in the presence of ethyl alcohol, complex compounds can be extracted by benzene, and between 480 and 680 millimicrometers there are 2 absorption peaks at 555 millimicrometers and 605 millimicrometers. The molecular absorption coefficients under these two wavelengths are respectively 7.0×10^4 and 8.2×10^4. Xu Shengjie [6079 3932 2638] et al[118] used this reagent to establish the method of directly determining 1×10^{-5} percent of antimony in pure aluminum and aluminum alloys without separation. Wei Junzhi [7279 0689 0037] et al[119] used MnO_2 to precipitate antimony in iron, and used citric acid to complex molybdenum, and established the crystal violet colorimetric method for antimony in pure iron and pure molybdenum.

The Shanghai Nonferrous Metals Institute[120] established the analytical method of using BPHA to extract and separate molybdenum and crystal violet for coloration of 5×10^{-5} percent molybdenum in highly pure zirconium. In addition, there is also the method of determining gold[121] using toluene to extract gold-crystal violet complex compounds, and the method of using EDTA to mask the interfering elements to determine boron in steel.[122]

3. Ethyl Violet: In the early period, Lin Huigai [2651 6540 2861] et al[123] studied the photometric method of extracting gold and Xu Shengjie [6079 3932 2638] et al[124] studied the photometric method of extracting thallium. Later, Wang Jixiang [3769 4480 4382] et al[125] more carefully experimented with the effects of coexisting ions and the method of eliminating interference. They showed that adding citric acid can allow 1 milligram of chromium to be present, and adding $SnCl_2$ to reduce gold, mercury and antimony can allow 100 micrograms of gold, 10 micrograms of mercury, 10 micrograms of antimony to be present. Wu Jingyang [0702 2529 7122] et al[126] studied the method of extraction of trace amounts of boron from ocean sediments using ethyl violet and measured $\varepsilon = 110,000$. Liu Xuan [0491 3872] et al[127] studied the photometric method of extracting antimony from pure silicon using ethyl violet. Xu Shengjie [6079 3932 2638][128] boiled H_2O_2 in a pH 2 solution to eliminate the interference of MnO_4^-, $Cr_2O_7^{2-}$, VO_3^-, and established the photometric method of extraction of rhenium from fine molybdenum ore using ethyl violet-benzene. The Shanghai Nonferrous Metals Institute[129] established the analytical method of using EDTA to mask zirconium and to analyze boron in zirconium alloys.

II. Application of Binary and Tertiary Complex Compounds

(I) Mixed Coordination Complex Compounds and Tertiary Ion Associates

Shi Huiming [0670 1979 2494] et al[35] introduced and explored theoretically the various factors that affect the formation of mixed coordination complex compounds and sought methods for forming mixed coordination complex compounds in an effort to guide the search for new tertiary complex compound systems and especially to seek new mixed coordination complex compound systems. Du Shikui [2629 1102 1145] et al[130] added ethyl alcohol in the coloration solution to prevent the occurrence of white precipitates when the tertiary complex compound of titanium-diantipyryl methane-allochromatic acid is used to determine titanium. Ascorbic acid was also added to eliminate interference by Fe^{3+} and V^{5+}. This method was used in the analysis of titanium in titanium residue and the result was good. Wang Zhongxin [3769 6850 0207][131] used the same tertiary complex compound system to analyze titanium iron, high titanium ore, titanium and its alloys. It is believed that the method is simple, the accuracy, repetitiveness and selectivity are all good. The composition of complex compounds is: titanium : allochromatic acid : diantipyryl methane = 1 : 2 : 2. Wang Yubin [3769 3022 6333][132] used the titanium-diantipyryl methane-stannous chloride system and chloroform extraction to determine titanium in steel, aluminum and aluminum alloys. The coloration solution did not change in 6 hours. Liu Shaopu [0491 4801 3877][133] used the photometric method of 1,10-phthalein-fluorescent pink extraction to determine copper, and conducted experiments in the composition and conditions of extraction of the tertiary complex compounds. He believed this method is superior to the existing method of using red and scarlet reagents. The composition of the complex compounds is: copper : phthalein : fluorescent pink = 1 : 2 : 1. Up to 100 micrograms of titanium, bismuth, and over 10 elements will not cause interference. Silver and zinc will cause interference. The method produced satisfactory results in determining copper in pure lead, iron, aluminum, ordinary steel, and pig iron. Later, he also used the same reagent to experiment with nickel.[134] He showed that in a neutral to weakly alkaline medium, nickel (II) and 1,10-phthalein and fluorescent pink form a complex compound (nickel (phthalein)$_2$) fluorescent pink that can be extracted by chloroform. In the presence of citric acid, thiocarbamide-ascorbic acid and triethanolamine, large quantities of iron, aluminum and several dozen to several hundred micrograms of Cu^{2+}, Mn^{2+}, Zn^{2+}, Sn^{2+}, Pb^{2+} will not cause interference, and in the analysis of nickel in lead, aluminum alloys, pure iron, carbon steel, the results were good. Huang Junhui [7806 0971 1920] et al[135] used the tertiary complex compound of silver-phthalein-bromobenzotriphenol to indirectly determine the cyanogen radical. Because (silver (phthalein)$_2$)$_2$ - bromobenzotriphenol easily precipitates and is unstable, the author heated it and changed the amount of the major reagent used and added a small amount of polyethylene alcohol to stabilize the reaction and prevent precipitation. The sensitivity of this method in analyzing seawater can reach the ppb level. Hua Fangxia [5478 2455 0204][136] improved the bromobenzotriphenol red-phthalein method. Adding animal gel and ethyl alcohol can extend the stable period of the coloration solution from 30 minutes to over 4 hours. Chen Youshan [7115 0645 0810] et al[137] experimented with using the tertiary complex compound cobalt-nitroso red-tri-n-octyl amine to determine cobalt. They pointed out that the complex compound had λ_{max} = 520 millimicrometers, ε_{520} millimicrometers = 1.31×10^4, the composition of the complex compound is cobalt : nitroso red : tri-n-octyl amine = 1 : 3 : 2. In the presence of citric acid, microgram amounts of Fe, Ti, Al, Ca, Mg do not interfere. The results of applying this method in determining cobalt in ores are satisfactory. Wei Fusheng [7614 1788 4141] et al[138] pointed out that in the presence of sodium n-caproic acid 1 to 3 percent, 5-chloro-pyridine azo-diethylaniline-m-phenol (abbreviated 5-Cl-PADAP) can form Pb : 5-Cl-PADAP : n-caproic acid = 1 : 1 : 1 violet red tertiary complex compound soluble in chloroform, λ_{max} = 570 millimicrometers, ε_{570} millimicrometer = 4.9×10^4, when determining lead, like the use of 5-Br-PADAP, KCN is required. Good results have been obtained in determining lead of 0.001 to 0.1 percent in mud and drugs. Gao Jianli [7559 1696 0500][53] proposed the use of benzene to extract the tertiary complex compound of Sb^{3+}, Sb^{3+} - I^- - 5-Br-PADAP to determine antimony. The composition of the complex compound is Sb^{3+} : I^- : 5-Br-PADAP = 1 : 4 : 1. ε_{630} millimicrometer = 5.5×10^4. The 17 elements such as zinc, cadmium, nickel, iron and tartaric acid radical, EDTA, citric acid radical, chlorine radical, sulfuric acid radical, nitric acid radical used in the experiment do not cause interference. The method is simple, the selectivity is good. The results of analysis of antimony in waste water, electrolytic solution and ores are satisfactory. Ren Hao [0117 3493] et al[139] studied the simple, convenient and quick method of using chloroform to extract the tertiary complex compounds formed by the complex anions of titanium sulfocyanate and diphenylguanidine to determine trace amount of titanium in aluminum alloys. Liu Shaopu [0491 4801 3877][140] used the titanium-alizarine S-diphenylguanidine system to study the method of analyzing cobalt in steel, $\varepsilon = 2.8 \times 10$, and showed that this method is more sensitive than the commonly used allochromatic acid method and the binary method of titanium and alizarine S. Yunnan University[141] used benzene extraction of the tertiary complex compound of Cd-I-crystal violet to determine cadmium in polluted water, $\varepsilon_{590} = 2.25 \times 10^5$. The selectivity of the method is good. In the experiment of interference by nearly 30 kinds of cations and anions, only Hg^{2+}, Cu^{2+} caused interference. Liu Changsong [0491 7022 2646] et al[142] pointed out the associates formed by fluotantalate and iodine green can be easily extracted by benzene. This method can be used for extraction and colorimetric determination of tantalum. The color of the associates extracted by benzene can remain stable for at least 90 minutes. $\varepsilon_{6[illegible]}$ millimicrometer = 9.8×10^4. Experiments of the interference by 27 kinds of anions and cations show the method's selectivity is good, and it is not affected by the content of titanium which can reach up to 16 milligram. Niobium will not cause any large effect under 1 milligram. The method has produced good results in the analysis of steel containing niobium and titanium and it is basically consistent with the crystal violet method.

(II) Complex Compounds of Colloidal Bundles To Increase Solubility

Spectrophotometric method of colloidal bundles to increase solubility is a new method developed during the latter part of the 1960's. The Department of Chemistry in our nation's Beijing University[143] first used acetyl acetone-carbon tetrachloride to extract and concentrate beryllium in natural water and eliminate the interference from F^-, Al^{3+}, and used beryllium-chromazurine S-hexadecane pyridine bromide (CPB) to determine beryllium of a content as low as 0.0002 milligram/liter, $\varepsilon = 8.1 \times 10^4$. Another system that uses CPB as the agent to increase solubility is the Sn-CPB-benzofluorenone system by Zhang Deliang [1728 1795 5328] et al,[144] ε_{510} millimicrometer = 1.9×10^5. The tin in ores is extracted and separated by iodides and then determined. Later, Zhang Zhaoyi [1728 0340 1355][145] used the same system and H_2O_2 tartaric acid to separately mask molybdenum, antimony and tungsten and directly determined tin in ores. Ding Jianquan [0002 1696 2938][146] used the method of anion exchange to separate niobium, tantalum and aluminum in 5MHF-1MHNO , and used Al-chromazurine S-CPB system to determine aluminum. Zhang Deliang [1728 1795 5328] et al[147] also used the Mo-CPB-benzofluorenone system to determine molybdenum in ore and steel, and pointed out this method is six times more sensitive than the method using hexadecane pyridine chloride (CPC). Liu Shaopu [0491 4801 3877][148] used the carminic acid-CPB-Ti system to determine titanium in steel, and showed the sensitivity of this method to determine titanium is 10 times higher than that of using only carminic acid to determine titanium. The composition of the complex compound is: Ti(IV) : carminic acid : CPB = 1 : 3 : 2. Seventeen kinds of ions such as Mg^{2+}, Bi^{3+}, Ce^{3+} do not interfere but MO^{6+}, W^{6+}, Th^{4+}, Zr^{4+}, V^{5+} do not cause interference. Weng Lida [5040 4539 6671][149] used the hemixylenol orange-CPB-Ca system to study the method of analysis of calcium in rocks and magnesium sand, at this time, $\varepsilon_{630\text{millimicrometer}} = 4.5 \times 10^4$. The Department of Chemistry of Yunnan University[150] proposed the use of Mo-bromo-o-benzotriphenol red-CPB system to determine molybdenum in ores. It showed that in 0.1 to 0.3 N Hcl, with the presence of ethyl alcohol, the complex compound molybdenum : CPB : bromo-o-benzotriphenol red = 1 : 1 : 1, $\varepsilon_{630\text{millimicrometer}} = 4.3 \times 10^4$. Ding Shuyun [0002 3219 0061][151] studied the method of determining tin in lead products directly using the Sn-CPB-o-benzodiphenol violet system in a nitric acid-citric acid medium. It is believed that the method is accurate, quick and highly sensitive. Another more frequently used agent to increase solubility is hexadecane trimethyl ammonium bromide (CTMAB). Guo Chunshan [6753 2504 1472] et al[152] used the tin-o-benzodiphenol violet-CTMAB system to study the method of determining tin in zinc products. The spectrum of zinc and the tin in chemical samples were analyzed and the results were satisfactory compared to other methods. The Guizhou Metallurgical Design Research Institute[153] used the Sn-CTMAB-benzofluorenone to determine tin in ores, and showed $\varepsilon_{510\text{ millimicrometer}} = 1.19 \times 10^5$, the concentration of tin is 0.02 to 0.4 ppm, satisfying Beer's Law. Immediate full coloration occurs under room temperature when oxalic acid is used as a catalyst. Another example of determining tin is the work by Dong Hong [5516 5725] et al[154] using iron-aluminum hydroxides to precipitate Sn, using the o-benzodiphenol violet-CTMAB-Sn system to determine tin in metallic nickel, copper and zinc. Ding Jianquan [0002 1696 2938][155] used the same system to determine tin in tantalum and niobium in a citric acid-sulfuric acid medium. Li Shaoqing [2621 4801 0615][156] used a mixed solution of isobutyl alcohol-benzene to extract the complex compound Th-azochlorophosphine III-CTMAB to determine thorium in ores. The percentage of retrieval in one extraction can reach 98 percent and the method is simple and quick. The Department of Chemistry of Nanjing University[157] used the complex compound o-benzodiphenol violet-CTMB-W in a mixed sulfuric-phosphoric acid and NaF medium to analyze tungsten in $W_6Mo_5Cr_4V_2$ steel and $3Cr_2W_8V$ steel and $W_{12}Cr_4V$ steel. Interference from iron, molybdenum, vanadium, chromium can be eliminated without separation using the reducing function of hydrochloric acid hydroxylamine and CyDTA's masking function. The $\varepsilon_{670\text{ millimicrometer}} = 5 \times 10^4$. The Department of Chemistry of Yunnan University[158] studied the method of determining titanium using the Ti(IV)-bromo-o-benzotriphenol red-CTMAB system in a KCl-HCl buffer solution. It pointed out that ε_{630} millimicrometer = 3.9×10^4. In the presence of citric acid and ascorbic acid, determination was carried out without any interference from over 40 cations and anions, and the method was successfully applied in the analysis of titanium in steel and ores. Chen Yindi [7115 7892 1229] et al[159] used CTMAB to increase the solubility of chromazurine S in determining aluminum. But in this method, the interference caused by coexisting ions is greater. Xiao Mantian [5135 3341 2944][160] used CTMAB or tetradecane dimethyl benzyl ammonium as the agent to increase solubility to study the method of analyzing magnesium in spheroidal graphite cast iron and used DCTA, DCTA-Ca to mask iron, and obtained good results. To determine beryllium oxide in air, Liang Zhili [2733 1807 4539] et al[161] used the illite chromicyanide blue R-CTMAB-Be system to determine beryllium to 0.04 micrograms Be/25 milliliters. In addition,Wang Huaigong [3769 2037 0361] et al[162] also used the Ni-xylenol orange-CTMAB system to study the method of analyzing trace amounts of Ni in soil. It is characterized by fast coloration, the color is stable, and selectivity is good. Sodium citric acid-Na_3PO_4 used as the masking agent for the Fe^{3+}, Al^{3+}, Cr^{3+}, Co^{2+} ions can rapidly determine nickel in soil without separation. Cases using hexadecane trimethyl ammonium chloride (CTMAC) as the agent to increase solubility include the work by Zhang Deliang [1728 1795 5328] et al[163] who used the Ge-CTMAC-benzofluorenone system to determine germanium in ores and the work by Ma Boxiang [7456 2672 4382] et al[164] who used the Fe-CTMAC-chromazurine S system to determine trace amounts of iron in highly pure lead, copper, indium, selenium. The Fujian Provincial Machinery Research Institute[165] used tetradecane dimethyl benzyl ammonium (Zeph) as the agent to increase solubility in the bromo-o-benzotriphenol-Zeph-Mo system to study the photometric analysis of molybdenum in steel. Zhou Jiaju [0719 1367 7467] et al[166] increased the efficiency of extraction and produced good separation of the layers by changing to the use of the mixed solvent chloroform-dichloro-ethane for extraction in determining calcium in ores using the Ca-Zeph-(ethyl dialdehyde (2-hydroxyl aniline)) system. Wang Yonglie [3769 3057 3525][167] used CPC as the agent to increase solubility, and studied the method of using xylenol orange to determine the total amount of rare earth, and established the method of using PMBP to extract rare earth and used rare earth-xylenol orange-CPC complex compounds to determine the total amount of rare earth in ores. Wu Cheng [0702 6134] et al[168] and Yu Weizhong [0151 5898 1813][169] used the PAN-Triton *-X- 100-Zn system to separately study the method of analyzing zinc in iron ore and the method of not using zinc to analyze zinc in such pure metals as copper, nickel, cobalt, magnesium, lead, and alloys of nickel-copper, nickel bronze, nickel aluminum alloys, tin phosphorus bronze, special bronze, tin based and lead based alloys, tin bronze, and magnesium alloys.

III. Application of Mathematical Methods

He Xiwen [0149 6932 2429] et al[170] used the domestically manufactured DJS-6 computer to explore the absorption spectrum of mixtures using linear categorization in place of the least square method, thus avoiding the occurrence of negative values. The complex compound of mixed rare earth-o-benzodiphenol

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*Surface active agent: isooctyl benzoloxy ethoxy ethyl alcohol.

violet and the tertiary complex compound of mixed rare earth-xylenol orange-hexadecane pyridine bromide were used as examples for computation. The results showed that regardless of whether one is determining heavy rare earth in light rare earth or determining light rare earth in heavy rare earth, calculating the component amounts of the parts of each of the six rare earths, the results were all fairly close to the theoretical values. There was no interference from coexisting elements, and the content of the interfering elements can be used as the component parts and calculated. At the same time, it was pointed out that the use of tertiary complex compounds can increase the differences among the parts and improve the accuracy of the computational results. Therefore, the computational results for the rare earth-xylenol orange hexadecane pyridine bromide system was much more accurate than that for the rare earth-o-benzodiphenol violet system. The computational results of tertiary complex compounds, whether for the total or the component amounts of rare earth, were all very satisfactory.

To facilitate the use of the computer to obtain the content of the products from reactions and the contents of the various parts of mixtures, Shi Huiming [0670 1979 2494] et al[36] introduced the use of spectrophotometric method to study the composition and the formation constants of mixed coordination complex compounds to facilitate writing of the computer program. Because the method for studying the composition and formation constants of mixed coordination complex compounds is more complex than that for binary complex compounds, therefore, the method selected must be appropriate. The methods for studying the composition of mixed coordination complex compounds introduced are: 1. physiochemical analysis--tertiary phase diagram; 2. restricted logarithm; 3. improvement of the Asmus straight line method. The methods for studying the formation constants of mixed coordination complex compounds are: 1. the method of dissociation; 2. improved isochromatic method.

IV. Study of the Foundations of Application

Li Xian [2621 6932 1344] et al[171] studied the standardization problem of determining the total amount of rare earth in ores using the azoarsenic III photometric method and showed that in a pH 2 to pH 3 formic acid solution, the addition of potassium chloride can suppress the photoabsorption of the yttrium-azoarsene III complex compound but will not affect the stability of rare earth complex compounds and the photoabsorption of rare earth complex compounds of the cerium group, thus obtaining consistency of the standard curves of rare earth elements of different proportions. The results obtained by using this method to determine the total amounts of rare earth of various proportions in ores are good.

The Third Shanghai Reagents Plant[172] pointed out that in the similar types of compounds of 2,7-dihydroxyl fluorescent yellow and o-benzodiphenolphthalein, alizarine violet is the best coloration agent for tin, but because domestic and foreign products are all impure, therefore when making the solution, it should be left overnight to filter out the residues. For this, the method of synthesizing superior quality alizarine violet using o-benzotriphenol and o-benzodimethyl acid anhydride has been proposed. Used in the determination of tin, it conserves the amount of reagent used, and it also reduces the blank value. It has been pointed out that strict control of the acidity is the key to success or failure in analysis, and a solution has been proposed and the properties of the reagent are introduced.

Huang Zuxian [7806 4371 6343][173] studied the mechanism of the reaction of bismuth salts to ascorbic acid molybdenum blue in a diluted nitric acid medium, and proposed that bismuth ions participate in the reaction to form tertiary complex compounds. Their participation ratio is: bismuth: phosphorus (arsenic): molybdenum = 1 : 1 : 12. The greatest absorption wavelength: 700 millimicrometers for phosphorus, 720 millimicrometers for arsenic. The manifested molecular absorption coefficient of phosphorus is: $\epsilon_{700\ \text{millimicrometer}} = 1.80 \times 10^4$, and that of arsenic is $\epsilon_{720\text{millimicrometer}} = 1.53 \times 10^4$.

V. Colorimetric Methods of Various Elements

The colorimetric methods used for various elements and the objects of analysis are simply listed in Table 1.

Conclusion

During the past 30 years, our nation's analytical chemistry achieved great development, especially photometric analysis, because it suits the present situation in our nation, therefore it has served its function and its development has been more rapid. As we exert efforts to develop various kinds of new methods of new instrumental analysis, we must pay attention to the development and improvement of the work and the standard of photometric analysis. Therefore, we should also strengthen our nation's studies and production of instruments used for spectrophotometry and organic coloration reagents, pay attention to basic research in photometric analysis and the application of new technology such as the application of the computer to develop towards a higher standard in photometric analysis and make greater contributions to our nation's "four modernizations."

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Table 1. Colorimetric Table Arranged According to the Elements

Elements to be determined	Methods of determination	Subject of determination and references
Silver	Quinaldine red	Lead zinc ore (174)
	Catalytic photometry $2Ce^{3+} + S_2O_8{}^{2-} \rightarrow 2\,Ce^{4+} + 2SO_4{}^{2-}$	(175)
	Bromo-o-benzotriphenol red--o-phthalein	Ore (136)
Aluminum	Aluminum reagents	Steel (176)
	8-hydroxy guinoline	Steel (177), beryllium (178), hot uranium solution (179)
	Eriochrome blue R	Steel and iron (180)
	Chromazurine S	Steel (77-80, 82, 83, 85), copper alloy (81,231) high vanadium iron (84), magnesium and alloys (181)
	Chromazurine S - hexadecane trimethyl ammonium bromide	Lubrcating oil (159)
	Chromazurine S - hexadecane pyridine bromide	Niobium and tantalum (146)
	Xylenol orange	Zinc alloy (182)
Arsenic	Ag-DDTC	Water (183, 184), urine (183), mud (185), steel (186)
	Bismuth-arsenic molybdenum blue	Steel and iron and ore (187)
	Arsenic molybdenum blue	Tellurium (188), steel (189)
Gold	Rose red	Pure silicon (190)
	Peacock green	Platinum group and alloys (111), Aniodic clay (191), copper (112)
	Ethyl violet	(123)

	Crystal violet	Ores (121)
	Bright green	Ores (192)
	Sulfur Michler's ketone	Ores (193)
Boron	Acetyl-1,2,5,8-tetrahydroxyl anthraquinone	Aluminum (194)
	1',1-anthraquinone-imine	Aluminum alloy (195), steel (196)
	1-hydroxyl-4-methylamine-anthraquinone	Steel (197)
	Curcumin	Graphite (198), UO_2 (199), steel (200)
	Methylene blue	Aluminum alloy and copper alloy (201), steel (202, 203), niobium, tantalum (203)
	Peacock green	Steel (116)
	Crystal violet	Steel and iron (122)
	Ethyl violet	Ocean sediments (126, zirconium and alloys (129)
Beryllium	p-sulfobenzene azo-allochromatic acid	Ores and alloys (204)
	Beryllium reagent II	Zinc-aluminum alloys (205), ores, minerals (206, 207)
	Beryllium reagent III	Magnesium and alloys (181)
	Chromazurine S	Copper alloys (86, 208)
	Chromazurine S -- hexadecane pyridine bromide	Natural water (143)
	Eriochrome blue R	Atmosphere (209)
	Saoluo chromazurine blue R-hexadecane trimethyl ammonium bromide	Atmosphere (161)
Bismuth	Xylenol orange	Aluminum and alloys (90), nitric acid radical (107)
	Vomic nut salt-K I	Copper alloy (210)
	Bromobenzotriphenol red	Copper ore, lead and zinc ore, tin ore, iron ore (211)

Bromine	Fe^{3+} -mercury sulfocyanate	Glass (212)
Calcium	Azo-arsine I	Steel and iron, aluminum and alloy (213)
	Azo-arsine III	Rocks (63), graphite (214)
	GBHA (dialdehyde-o-amino-phenol)	Steel and iron (215), rare earth (216)
	GBHA-hexadecane dimethyl benzyl ammonium	(166)
	Xylenol orange	Mineral ore (104)
	Hemixylenol orange-hexadecane pyridine bromide	Rocks and magnesium sand (149)
Cadmium	Disulfohydrazone	Zirconium (217), tellurium (188)
	Bromobenzothiazolyl azo naphthol	Water (213)
	Cadmium-iodine-crystal violet	Polluted water (141)
	Cadmium reagent 2B	Aluminum and alloys (219)
Cerium	Ce^{4+} -vomic nut salt	Cast iron (220)
	Sodium o-benzodiphenol disulphonic acid	Lanthium oxide (221)
Chlorine	Fe^{3+} - mercury sulfocyanic acid	Graphite (222), glass (212)
Cyanogen radical	Silver-o-phthalein-bromobenzotriphenol red indirect method	Seawater (135)
	Pyrazolone-isonicotinic acid	Water, urine, serum (223)
Sulfocyanate radical	After converting to cyanogen, used the pyrazolone-isonicotinic acid method	Water, urine, serum (223)
Cobalt	5-Cl-PADAB	Steel and iron (49,51), ores (50)
	Sulfocyanate-diphenylguanidine	Nickel (224)
	EDTA-H_2O_2	Cobalt based alloys (225)
	Nitrous R	Beryllium (178), ores (137) copper alloys (208)

Chromium	Diphenyl carboxyl dihydrazine	Steel and iron (226,227), copper (226), vanadium and alloys (227), molybdenum and alloys (228)
	EDTA	Copper alloys (208)
	1,5-diphenyl-diamino urea	Aluminum and alloys (229)
Copper	Xylenol orange	(93)
	BCO (bicyclohexanone oxalyl dihydrazone)	(230), aluminum and magnesium (231), cast iron (227), magnetized steel (232)
	CyDTA	Silver, alloys of nonferrous metals (233)
	DDTC	Aluminum and alloys (229), magnesium and alloys (181), platinum (234)
	Benzohydrazine carbonyl azobenzene	Zirconium (235)
	1,10-phthalein-fluorescent pink	Steel, lead, iron, aluminum (133)
	5-Br-PADAP	Table salt, hair, water (54)
	Cu^{2+} p-Fe^{3+} + $S_2O_3{}^{2+}$ catalytic reaction	Living objects and soil (236)
Fluorine	Thorium-thorium reagent decoloration	Pyrite (237)
	Thorium-xylenol orange decoloration	(89)
	Lanthium-alizarine complexing agent	Oxalic acid (238)
Iron	Sulfocyanate	Silicon, iodine, zinc (239)
	3,5-disulphonic acid o-benzodiphenol	(240)
	Sulfosalicylic acid	Magnesium and zinc alloys (241)
	EDTA-H_2O_2	Aluminum, bronze (242)
	Acetyl acetone	Copper alloys (243)
	Chromazurine S-spermaceti trimethyl ammonium chloride	Copper, lead, indium, selenium (164)
	O-phthalein	Magnesium and alloys (181), chromium, vanadium (244), steel (245), tungsten (246), yttrium oxide (247)
	Nitrous R	Nonferrous metals and alloys (248)

Gallium	1,2,5,8-tetrahydroxyl anthraquinone	Ores (249)
	Peacock green	Aluminum (109)
	Benzofluorenone	(250)
	PAR	Ores (48)
	Butyl rhodamine B	Aluminum (251)
	Rhodamine 6G	Aluminum and ocean sediments (252)
Germanium	Violet gallein	Chimmy ash (253)
	Benzofluorenone	Ores (254)
	Benzofluorenone-hexadecane trimethyl ammonium chloride	Sandy ore, dust and powder (163)
Hafnium	Xylenol orange	Zircon (101)
	Azo-arsine III	Zircon (255)
Mercury	PAN	(38), ores (37)
	5-imidothiazoline-2-sulfoformamide (Chrysean) method	(256)
	Rhodamine 3B	Foodstuff, living beings (257)
Iodine	$IO_3^- + 5I^- + 6H^+ = 3I_2 + 3H_2O$ starch	Silicon (258)
	Ethyl violet	Ocean sediments (259)
Indium	Rhodamine 6G	Aluminum and alloys (260)
Iridium	Stannous iodide	(261)
	Stannous chloride-bromohydrogen acid	(262)
	Ce^{II} $-As^{III}$ reaction catalyzed by yttrium in the presence of mercury	(263)
	Catalvtic method of Cu(I) using iridium to oxidize KIO_4	(264)
Lithium	0-(2-hydroxyl-3,6-disulfo-1-azonaphthol) phenyl arsinic acid	Zinc (265)

Magnesium	Tartar yellow	Cobalt (266)
	8-hydroxylquinoline-butylamine	Graphite (267)
	Chromotropic acid 2R	Aluminum alloy (268)
	Methyl thymol blue and thymol phthalein complexing agent	Cast iron (269)
	TTA-methyl blue	Titanium tetrachloride (270)
	Methyl phenol blue	Rare earth magnesium alloys (271)
	Xylenol orange	Ores (104)
	Dimethyl benzo-amino blue II	Nickel (272), cast iron (273), ores (274), rare earth (216)
	Dimethyl benzo-amino blue I - chloro-tetradecane demethyl benzylamine	Cast iron (160)
	Chrome black T	Cast iron (275), aluminum alloy (275), copper, nickel, zinc (275), tin bronze (243)
	Azochlorophosphine I	Cast iron (67), aluminum alloy and zinc alloy (65), (64)
Manganese	Manganese, silicon, phosphorus automatic colorimetric analysis	Steel and iron (276)
	Mn (III)-trimonoethanolamine	High manganese materials (277)
	Formaldehyde oxime	Molybdenum, molybdenum oxide (278)
	H_2O_2 present with salicylaldoxime	Single minerals (279)
	Permanganic acid	Magnesium, magnesium alloy (181), cast iron (227)
	Permanganic acid	Aluminum, aluminum alloy (229)

Molybdenum	Crystal violet	(117), zirconium (120)
	Sulfocyanic acid	Urine (280), steel (281), ores (282)
	Bromo-o-benzotriphenol red-tetradecane benzylamine chloride	Steel (165)
	Bromo-o-benzotriphenol red-hexadecane pyridine bromide	Ores (150)
	Tetrabenzene arsine chloride-sulfocyanic acid	Tungsten steel (283)
	Benzofluorenone-hexadecane pyridine bromide	Ores, steel, iron (284)
	Dithioacetic acid or β-dithiopropionic acid	Tungsten steel (285)
	Ammonium dithio-methyl acetic acid	Molybdenum iron (286)
Sodium	Indirect method of precipitating sodium in the presence of Fe^{3+} and ethyl alcohol using NH_4F and using sulfosalicylic acid to determine iron	Ores (287)
Niobium	Sulfocyanic acid	Tantalum oxide (288), tungsten tin ore (289)
	Tantalum reagent-sulfocyanic acid	Aluminum (290)
	Tetrabenzene arsinic-sulfocyanic acid	(291)
	Chrome blue Black B	(292)
	Acidic chrome blue K	(293), ore (294)
	PAR	Tungsten (295), steel (43,44)
	Catalytic method: Nb^{5+}-o-aminophenol-H_2O_2-tartaric acid system	(296)
	N,N'-di(2-hydroxyl-5-sulfophenyl)-C-cyanoformazane	Ores (297), steel (298)
	3-diethylamino-6-(2-thiazolyl azo) phenol	(299)
	4-(2-thiazolyl azo) benzodiphenol	(300)
	Chlorosulfophenol S	Steel (301)

	Iodine green extraction	Steel, titanium dioxide (142)
	Bromo-benzotriphenol red	Ores (302)
	Xylenol orange	Steel (106)
Nickel	Butyl dioxime	Copper alloy (243), aluminum and alloys (229), magnesium (181), steel (303)
	Butyl diketo-oxime	Urine (280)
	α-furil dioxime	Beryllium (178)
	α-furfuran oxime	Copper, copper ore (304)
	PAN	Graphite (305)
	1,10-phthalein-fluorescent pink	Steel, aluminum and alloys (134)
	Xylenol orange	Soil (162)
Nitric acid radical	2-ethoxy-6,9-diaminioacridyl	Water, soil, vegetables (306)
	Thymol	Water (307)
Neptunium	Azo arsine K	Uranium (308)
Phosphorus	Phosphorus molybdenum blue	(309), steel (310), cast iron (227)
	Phosphorus molybdenum blue, bismuth salt-ascorbic acid reduction	(173)
	Phosphorus vanadium molybdenum yellow	Copper alloys (243)
	Indirect method of benzofluorenone-molybdenum	$SiHCl_3$, $SiCl_4$ (311)
Lead	Xylenol orange	(94)
	Xylenol orange and hemixylenol orange	Copper alloys (100)
	PAR	Copper alloys (45), tin alloys (46)
	Disulfohydrazone	Copper (312)
	5-chloro-pyridine azo-diethylamino phenol	Dirty mud, dregs (138)
Palladium	4-(2-thiazolyl azo) benzodiphenol	(313), catalyst, anodic clay (314)
	5-Cl-PADAB	Anodic clay platinum group metals (52)

Osmium	AsO_3^{3-} - $HgSo_4$ - Ce^{4+} system catalysis	Ores (315)
Rhenium	Ethyl violet	Fine molybdenum ore (128)
	Methylene blue	Fine molybdenum ore (316)
Rare earth	PAR	(41)
	Azo arsine I	Copper (317)
	Azo arsine III	Ore (60,171), apatite (62), cast iron (61), steel (318,319), copper alloy (208), zircon (255), titanium, uranium, rock (319), light rare earth in yttrium oxide (320)
	Azo arsine III-diphenylguanidine extraction	(59)
	Dicarboxyl azo arsine III	
	Azonitrocarboxyl	Ores (55-58)
	Azochlorophosphine III	Steel and iron (70-76)
	Dibenzoyl methane	Ho, Er, Tu in mixed rare earth
	Xylenol orange-hexadecane pyridine chloride	Ores (167)
	Absorption spectrum of rare earth complex compounds analyzed by mathematical methods	(170)
Rhodium	$KI-SnCl_2$	(323)
	Difference method of high contents in the $Rh(III)-SnCl_2$ system	(324)
Ruthenium	Arsenious acid-mercury nitric acid-Ce^{4+} system catalytic photometry	(315)
Sulfur	Indirect method by burning:	
	Decoloration reaction of SO_2 upon MnO_4	Steel and iron (325)
	Methylene blue	Silicon (326), chromium (327)

Antimony	Crystal violet	Iron, molybdenum (119), aluminum and alloy (118)
	Ethyl violet	Silicon (127)
	Peacock green	Copper alloy (115)
	PAN-KI	(39)
	PAR-KI	Cast iron (328)
	O-benzodiphenol violet	Cast iron (329)
	5-Br-PADAP	Waste water, electrolytic solution, ores (53)
	KI	Copper alloys (208)
Scandium	Xylenol orange	(91)
	Xylenol orange and 5,7-dichloro-8-hydroxyl quinoline	(92)
	Azo arsine III	Fine tungsten ore (330)
Selenium	3,3'-diamino-aniline	Indium, gallium, arsenic (331), tellurium (188), steel (332)
Silicon	Silicon molybdenum blue	(333), copper alloy (208, 334), cast iron (227), pure iron (335), nickel (335)
	Silicon, phosphorus, manganese automatic colorimetric analysis	Steel and iron (276)
Tin	Benzofluorenone	Molybdenum, iron (336)
	Benzofluorenone-hexadecane amine bromide	Ores (144, 153)
	Benzofluorenone-hexadecane pyridine	Ores (145)
	Hematine oxide	Steel, alloys (337)
	Quercitron	Copper alloys (243)
	Peacock green	(338)
	Alizarine violet	(172), copper alloy (208), lead (339)

	O-benzodiphenol violet-hexadecane trimethylamine	Zinc (152,154), nickel, copper (154), niobium, tantalum (155)
	O-benzodiphenol violet-hexadecane amine bromide	Lead (151)
	O-benzodiphenol violet	Copper alloy (340)
Tantalum	Benzofluorenone	Ores (341)
	Tantalum (V)-o-benzotriphenol-H_2O_2-tartaric acid system catalytic photometry	(342)
	Peacock green	Ores (109)
	Pyrogallic acid	Nickel based alloys (343)
Tellurium	Sulfo-urea	Gallium, indium (344)
	Hydrogen bromide	(345)
Thorium	Alizarine yellow	(346)
	Thorium reagent	Monacite (347)
	Xylenol orange	(88)
	Azo arsine III	Niobium, tantalum ore (64), zirconium, hafnium solution (348), rare earth, uranium, rock, steel (319)
	Azochlorophosphine III-hexadecane trimethylamine	Ores (349)
	Azo arsine K	(350)
Titanium	Titanium test	Thorium, uranium, rock, steel (319)
	BPHA method	Lead (351), zirconium (352)
	Azo arsine III	(353)
	Allochromatic acid	Copper alloy (208), aluminum and alloy (229)
	Ascorbic acid	Steel (354)
	PAR-H_2O_2	(42)
	Sodium alizarine sulfuric acid	Steel and iron (355)

	Alizarine S-diphenylguanidine extraction	Steel and iron (140)
	Trioctyl phosphine oxide-sulfocyanic acid	Aluminum (356)
	Diantipyrine methane-allochromatic acid	Titanium ore, titanium alloy (131), titanium residue (130)
	Diantipyrine methane	Aluminum alloy (132)
	Bromo-o-benzotriphenol hexadecane pyridine bromide	Ore, steel and iron (158)
	Carminic acid-hexadecane pyridine bromide	Steel (148)
	Sulfocyanic acid diphenylguanidine	Aluminum alloy (139)
Thallium	Ethyl violet	(124, ore (125)
	Rhodamine B	Tellurium (188)
	Xylenol orange	Air (99)
	Peacock green	Gallium, molybdenum (113)
Uranium	Azo arsine III	Niobium, tantalum ore (64), zircon (255), rare earth, thorium, rock, steel (319)
	Azo arsine III-diphenylguanidine extraction	Waste water (357)
	Azochlorophosphine III	Seawater (68), adsorption agent (69)
	Nitrate absorption spectrum	U(IV), U(VI), Pu(III), Pu(IV) mixed solution (358)
Vanadium	Sodium diphenylamine sulphonic acid	Uranium oxide (359)
	2,2'-dihydroxyl dianiline	WO_3 (360)
	BPHA	Graphite (361)
	2,(2'-thiazolyl azo)-5-diaminophenol	(362)
	PAR-H_2O_2	Steel (363), ore (48)
	Xylenol orange	Steel and iron (95, 96)

Tungsten	Sulfocyanic acid	Steel (364), molybdenum (355)
	Sulfocyanic acid-peacock green	Zirconium (366)
	Tungsten molybdenum blue	Steel (367)
	O-benzodiphenol violet-hexadecane trimethyl ammonium bromide	Steel (157)
Zinc	Zinc reagent	Ore (368)
	PAN	Nickel, cobalt (40)
	PAN-Triton-X-100	Ore (169), nonferrous metals (168)
	Disulfohydrazone	Nickel (369)
	Xylenol orange	Magnesium and alloys (97), aluminum and alloys (98)
	Peacock green-sulfocyanic acid	Electrolytic nickel solution (114)
Zirconium	Xylenol orange	Steel (87), aluminum (102), hot uranium solution (103)
	Azo sulfophenol C	Ores (370)
	Azo arsine III	Thorine, uranium, rocks (319), zircon (255)
Technetium	^{99}Tc-KCNS	Fission products (371)

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APPLIED SCIENCES

MAJOR DEVELOPMENT IN PRODUCTION OF CHINESE ACCELERATORS

Beijing GUANGMING RIBAO in Chinese 16 Nov 80 p 2

[Article by Mao Zhenlong [3029 2182 3891]: "Major Advances Made in the Development and Building of Chinese Accelerators, Gradual Applications Made to National Economy"]

[Text] A number of Chinese research institutes, universities and plants have engaged in the development and building of accelerators. To date about 30 different models of low energy accelerators have been built and applied to various aspects of the national economy.

The electron induction accelerator at the Automation Institute of the First Ministry of Machine Building has carried out thick parts flaw inspection for many units in China and has uncovered serious defects in a good deal of imported equipment for which the foreign suppliers had to apologize and make compensation. The Shanghai People's Electric Machinery Plant used accelerator-radiated polyethylene as the main winding insulation in an underwater electric generator and obtained good results. The Shanghai Solvent Plant and Shanghai Institute of Chemical Engineering have conducted radiation polymerization on triformaldehyde and obtained high purity products free of toxicity. Nanjing University and Jiansu Institute of Chemical Engineering fabricated ion-exchange membranes by radiating polyethylene with an electron linear accelerator. Good results have also been achieved in joining polyethylene films with accelerator radiation by the Jilin Shijinggou United Chemicals Plant and by the Jiangsu Wuxi Color Printing Plant. This polyethylene material has found wide applications in petrochemical and electrical engineering and also in civil and military industries because of its unique heat-resistant, mechanical, electrical and "memory effect" properties. Tianjin 609 Plant has been mass-producing radiation-joined polyethylene electrical cables and vulcanized silicone rubber. After radiation treatment, the transient working temperature of the insulation layer can reach 250°C and the machining temperature has also been increased substantially. Shanghai Technical University used an accelerator in the solidification of paint and achieved strong adhesion, bright texture and good quality. The Tianjin Pharmaceutical Plant and Tianjin

Institute of Technical Physics radiated an antibiotic strain with the accelerator and improved the quality by inducing transmutation. The Chinese People's Liberation Army Hospital used a linear electron accelerator in the treatment of cancers of the lung, the oesophagus, and of the cervix. Brain tumors, malignant lymphatic tumor and nasal and pharyngital cancers are also treated with accelerator radiation. Clinical observations have shown that accelerators are effective in cancer treatment. The Beijing Institute of Tumor Prevention has conducted cancer treatment for 2 years using the Chinese-made model BT-10 linear electron accelerator and cured almost 1,000 patients. Observation of immediate effects on some patients shows that the accelerator is a very effective tool for treating cancer. Beijing Normal University and 508 Plant of the Ministry of Posts and Telecommunication have produced semiconductor components with ion implantation machine and conducted metallic surface property modification experiments with ion implantation. Tests show that the ion implantation results are very encouraging. There are many more examples like the ones described above.

The Chinese accelerator industry has made great progress since the "gang of four" was crushed. Large accelerators such as high energy accelerator, heavy ion accelerator and synchrontron accelerator are being built. Some high power radiation accelerators are being assembled and tested. Also under construction are 4.5 MeV Van der Graaff accelerator, 2x6 MeV tandem accelerator and 200 MeV linear electron accelerator for nuclear physics uses.

The large number of technical people trained through practice has also established a basis for future development. In late October of this year, the Chinese Particle Accelerator Society assembled in Shanghai for its inauguration meeting where a dozen scientific reports were presented and the first term council was elected.

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WARNINGS TO BE HEEDED TO AVOID INJURIES ON TESTING GROUND

Beijing HANGKONG ZHISHI [AERONAUTICAL KNOWLEDGE] in Chinese No 1, 6 Jan 81 pp 12-13, 14

[Article by Yuan Jinchuan [0765 6855 2123]:"'The Naughty Boy' of Our Testing Ground"]

[Text] As soon as the siren sound of the ambulance faded, the bad news of the "naughty boy" being injured spread through the testing ground. Everyone in the car was speculating except engineer Zhang. He acted as though he had predicted this accident. Staring at the car window, he said to himself: "The naughty boy could have been prevented from entering the danger zone, but everyone was busy; no one paid any attention; consequently, the accident occurred...."

Worn Out "Iron Shoe"

The "naughty boy" Zhao Muchen [6392 2606 3089] fell in love immediately with the rocket vehicle when he came to the rocket testing ground.

Engineer Zhang was responsible for the indoctrination activities of the young students. After observing the first test of the rocket vehicle, Zhao suggested that the sliding blocks which support the rocket vehicle should be replaced by wheels to increase its speed. To explain why sliding blocks are used, engineer Zhang offered the following lecture; "We note that instead of using wheels as on conventional vehicles, the rocket vehicle is equipped with "iron shoes," or sliding blocks which move along steel tracks. To answer Zhao's question, let us perform a simple calculation. Suppose that the speed of a rocket vehicle is 300 m/sec (1,080 km/hr), and the diameter of the wheel is 0.5 m, then the rotational speed of the wheel will be 11,459 rpm. The actual speed of a rocket vehicle can reach several thousand or even 10,000 km/hr; in other words, the wheels will be rotating at tens of thousands or 100,000 rpm (by comparison, the wheels of a high speed train or automobile only rotate at 700-800 rpm). Furthermore, rocket vehicles may sometimes be subject to tons of vertical load. To design high speed bearings that can withstand such large load is a very difficult task.

Because a rocket vehicle travels close to the ground at very high speeds, it may be subject to several tons of lift force due to ground interference effects. In order to prevent the rocket vehicle from "taking off," the sliding block is shaped so that it hugs the rail track (Figure 1 [not reproduced]) to restrain its upward movement.

Equipped with the "iron shoes," the rocket vehicle moves smoothly along the rail track. However, the "iron shoes" wear out quickly. In order to prolong the life of "iron shoes," the rail track is coated with a layer of lubricant--usually a low-melting-point metallic alloy such as lead or zinc alloy (Figure 2 [not reproduced]). The heat generated between the rail and the sliding block is dissipated through the rail surface, thereby preventing corrosion and wear of the rail and the sliding block.

When the speed of a rocket vehicle exceeds 6,000 km/hr, it becomes impractical to use sliding blocks directly over the tracks. A rail track extending several kilometers cannot be made perfectly straight; if there is a slight deviation from a perfect straight line, the sliding block will grind against the rail and deteriorate rapidly. To overcome this difficulty, the space between the sliding block and the steel rail is filled with compressed air so that the sliding block is not in direct contact with the rail (Figure 3 [not reproduced]). Another way to solve this problem is to rely on magnetic force to lift the vehicle; in this case, it is called a magnetically suspended rocket vehicle (Figure 4 [not reproduced]).

"A Falling Leaf Can Break Your Head"

Zhao was a diligent student and full of curiosity, but he was also extremely treacherous.

One day a biological experiment was being conducted using a chimpanzee on the 306D rocket vehicle, which was estimated to travel at a maximum speed of 1,200 km/hr. If not under cover, anyone located at the apex of the triangular warning zone should be at least 100 m away from the track.

However, in order to observe his partner closely, Zhao concealed himself at a location only 10 m from the track, which happened to be the point where the rocket vehicle reached maximum speed, and was designated as the second warning zone.

Upon ignition of the rocket engine, the vehicle roared toward him at lightning speed. In the midst of the dust cloud stirred up by the rocket vehicle, a black object flew over his head. Excited, Zhao immediately chased after the object and found it to be a piece of synthetic leather torn from the chimpanzee's clothing.

Afterwards, he turned over the object to engineer Zhang. Zhang was startled to hear this story and said: "If this object had hit your head, you probably would have suffered a brain concussion!"

Zhao was not convinced: "How can such a soft object do any harm?"

Zhang replied: "You're really a naughty boy! Do not underestimate this soft object. Even a leaf dropped from the rocket vehicle can break your head!" Since then Zhao Muchen got the nickname "a naughty boy."

"How is it possible that a leaf can break one's head?" Zhao wondered. The next day he found engineer Zhang and asked.

When he heard Zhao's question, Zhang laughed and said: "Indeed, one must use extreme caution when dealing with a rocket vehicle moving at high speed. For illustration let us consider the following simple example.

"If we assume the speed of the 306D rocket vehicle to be 1,200 km/hr, the weight of a leaf to be 2 grams, and the time of impact between the leaf and one's head is 5×10^{-4} seconds, then the impact force is approximately 136 kg. This example shows that even though the leaf weighs very little, if it hits an object with large relative speed within a very short time, the resulting impact force can be very large indeed. You know how it feels if you run into a tree when standing on a fast-moving automobile. And the speed of an automobile is only several tens of kilometers per hour!

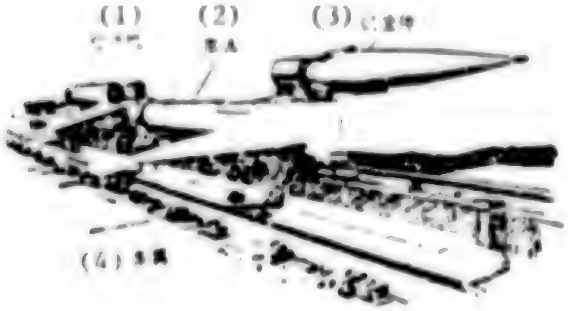
"Since a moving rocket vehicle may release small parts which are damaged by vibration or unstable aerodynamic forces, it is essential for test ground workers to observe safety precautions. During our previous tests, there were cases where birds, dogs, or rabbits were demolished by the rocket vehicle.

"In a few days, we are going to conduct a supersonic test on precision instruments using the 429 rocket vehicle. To ensure safety, a special rocket vehicle will be launched to drive away birds before the test."

Strange Looking Wings

The naughty boy was completely infatuated with the interesting rocket vehicle. He was particularly amazed at what he saw in the warehouse where rocket vehicles are stored. Noting that many rocket vehicles have small fins, he asked engineer Zhang what they were for.

Zhang replied: "These fins (Figure 5) are used to generate negative lift force and drag force. When the rocket vehicle travels very close to the ground, huge lift force and pitching moment are generated due to ground interference effects. To balance the lift force and pitching moment so the vehicle can travel smoothly along the track, negative lifting surfaces must be installed at the appropriate locations on the vehicle. The function of these surfaces is just opposite to that of airplane wings.



Key: (1) engine
(2) vehicle body
(3) test piece
(4) wing

Figure 5

"The drag producing fins are similar to the spoilers used on an airplane. If the track is not long enough for a particular test, or if large deceleration load is to be generated, it is necessary to apply brakes to the vehicle. Although a water trough is specially designed for braking the vehicle, aerodynamic drag fins are also commonly used particularly in the case of monorail rocket vehicles. The drag fins are controlled by a special control mechanism to provide proper timing and to adjust fin opening according to the ballistic motion."

Accident in the First Warning Zone

On this particular day, a 429 rocket vehicle was used in a test where the maximum speed would reach Mach 2.3.

To be safe, Zhao hid at a location 100 m from the track, thinking that anything ejected from the rocket vehicle certainly would not travel this far.

Fifteen minutes before ignition, a piercing alarm sound traveled through the air. Everyone in the first warning zone retreated to the shelter area within 5 minutes. Although the "naughty boy" was 100 m from the track, he was still inside the first warning zone. He did not return to the shelter area, however. Encouraged by his last experience, he was now bolder than before.

When the rocket vehicle came to a halt after completion of the test, a test ground worker found the naughty boy lying unconscious on the ground near the water trough.

When engineer Zhang arrived at the hospital, the doctors were trying to revive the boy, who was still unconscious. Three days later, Zhang visited him again in the hospital. He told Zhang that this time he did not see anything; all he remembered was a loud thundering noise before he lost consciousness.

After the naughty boy was released from the hospital, Zhang gathered the students and gave a lecture on the topics of pressure, shock wave, and sonic boom as related to rocket vehicle testing.

He said: "A rapidly moving rocket vehicle pushes the air molecules forward and thus compresses the air in front of the vehicle; at the same time, the space behind the vehicle is evacuated so quickly that a low pressure region is created. Consequently, a large pressure difference exists along different parts of the rocket vehicle. This pressure difference was responsible for tearing the chimpanzee's clothing during the last test.

"When the speed of the vehicle reaches supersonic, the air molecules in front of the vehicle do not have time to be dispersed before the vehicle overtakes them. As a result, a wall of air molecules is formed at the front part of the vehicle; this is called a shock wave.

Across the shock wave exists a large discontinuity in pressure and density. If the shock wave hits an object or a person close to the rocket vehicle, the shear force created by the pressure difference may destroy the object or cause the person to be injured or even killed. Therefore, during a supersonic test, no person or instrument is allowed to be exposed in the first warning zone.

"The disturbance created by a shock wave can propagate over a distance of several thousand meters. The sudden change in air pressure is interpreted by the human eardrum as a loud thunder; this is the so-called sonic boom. A weak sonic boom will cause irritation or shock in a person; a strong sonic boom may cause biological damage and break one's eardrum. Although the naughty boy is now out of the hospital, this lesson should be long remembered."

Inside the Shelter

After this incident, the naughty boy no longer tried to wander around on his own. One day he was inside the shelter watching rocket vehicles being tested through a safety-glass window.

He saw the rocket vehicle racing down the track with a 10-m flame trailing behind. Suddenly something happened. The rocket vehicle derailed, and shot out from the left side of the track, demolishing a cement pole; the cement pole in turn cut the rocket vehicle in half. The naughty boy was so startled by what he saw that his mouth dropped open.

Five days later at a certain meeting, engineer Zhang presented a brief analysis of the accident. He said: "The sliding blocks of the rocket vehicle are designed such that its vertical motion is constrained. However, due to unevenness in the steel rails, there is a gap between the rail and the sliding block. During high speed motion, intense vibration may occur in the vertical direction. In this test, a horizontal tail wing was installed on the vehicle. A model of this tail wing had been tested in the wind tunnel, but the rigidity and mass distribution of the model differed considerably from the actual wing. Although this difference had been taken into account in designing the rocket vehicle, a certain amount of error remained. The flutter experienced by the tail wing during this test exceeded the estimated vibration level used in the design. The overload sheared off several bolts from the sliding block, and totally destroyed the block. Once the upward constraint was removed, the lift force generated by ground interference effects caused the rocket vehicle to derail."

This analysis completely clarified for Zhao the causes of this accident. He said to himself: "There is sure a great deal to learn!" Also, he realized how much knowledge he had already gained from Zhang since he came to the testing ground. He was assured that rocket rail testing is really an important and meaningful job. He was determined to put his best efforts into learning and doing a good job. The naughty boy was now even more in love with the rocket vehicle than ever before.

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BRIEFS

MEDICAL RESEARCH--Beijing, 13 Feb (XINHUA)--The Chinese Academy of Medical Sciences made 31 scientific and technological achievements in 1980. A new drug "605" developed by the Hematology Institute is effective in treating scleriasis and thrombotic vasculitis [xue shuan bi sai xing xue guan yan 5877 2633 7028 1049 1840 5877 4619 3508]. The Pharmacology Institute developed a new drug, semi-synthetic [san jian shan zhi jian 0005 1423 2619 7927 4354], for treating acute non-lymphatic leukemia. The Basic Medicine Institute, the Cardiovascular Diseases Institute and the Hygiene Institute have used nontraumatic treatment [wu chuang shang xing liao fa 2477 0482 0281 1840 4070 3127] on plateaus 2,800 to 4,500 meters above sea level and carried out studies on various plateau health subjects. The Capital Hospital has made encouraging achievements in clinical studies in supplying nutrients through channels other than the gastrointestinal system. [Beijing XINHUA Domestic Service in Chinese 0225 GMT 13 Feb 81]

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A Device for the Determination of the Instantaneous Velocity of Raft Models by Lasers......Xu Fuchao [6079 6534 6389], Wang Yaoxiang [3769 6460 3276], Chen Wencai [7115 2429 2088], Qiu Duozhi [6726 1122 4363] and Sun Zhenguo [1321 2182 0948], all of the

Hydraulic Engineering Laboratory, Hunan Forestry and Design Institute (14)

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[Text] A New Genus and Species of Trachymedusae from Yantai...... He Zhenwu [0735 2182 2976], Department of Biology, Xinxiang Normal College, Henan (329)

Studies on Some Species of Gasterostome Trematodes from Fujian, China......Wang Puqin [3076 3302 2953], Parasitological Research Laboratory, Fujian Normal University (335)

Studies on Microphallid Trematodes from China, VI. Two New Species of the Genera Microphalloides and Odhneria......Ke Xiaolin [2688 1420 7792], Department of Parasitology, Zhongshan Medical College, Guangzhou (340)

Eleven New Species of Dactylogyrus (Trematoda: Monogenea) from China......Zhang Jianying [1728 0494 5391], Department of Biology, South China Teacher's College; Ji Guoliang [4764 0948 5328], Department of Fisheries, Central China Agricultural College (351)

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A Preliminary Study of Trochosa Koch. and Pirata Sundevall of Shaanxi (Arachnida: Araneida: Lycosidae)......Zheng Zhemin [6774 0772 3046] and Qiu Qionghua [6726 8825 5478], both of the

Department of Biology, Shaanxi Normal University (380)

Two New Trombiculid Mites of the Genus Herpetacarus (Acarina: Trombiculidae)......Wang Dunqing [3769 2415 3237], Liao Haorong [1675 3493 3310] and Lin Zuhua [2651 4371 5478], all of Fujian Research Institute of Epidemic Diseases (385)

A New Species of the Genus Tenuipalpus (Acarina: Tenuipalpidae) ......Wang Huifu [3769 1979 5346], Institute of Zoology, Chinese Academy of Sciences (387)

A New Species of the Genus Choroterpes from Nanjing (Ephemeroptera: Leptophlebiidae)......You Dashou [1429 1129 1108], Wu Tian [0702 6879] and Gui Hong [2981 7703], all of the Department of Biology, Nanjing Teacher's College; Xu Yinqi [1776 5593 4388], Shanghai First Medical College (390)

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A New Genus and Two New Species of Anthomyiidae (Diptera)...... Xue Wanqi [5641 8001 3823], Benxi Municipal Health Station, Liaoning (417)

New Species and New Subspecies of the Family Sphingidae (Lepidoptera)......Zhu Hongfu [2612 1736 1788] and Wang Linyao [3769 2651 3852], both of the Institute of Zoology, Chinese Academy of Sciences (425)

Three New Species of Telenomus (Hymenoptera: Scelionidae)...... Chen Tailu [7115 3141 7627] and Wu Yanru [0702 3601 1172], both of the Institute of Zoology, Chinese Academy of Sciences (429)

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New Records of Whale-Lice from China......Zhou Ningqi [0719 0413 3825], Dalian Museum of Natural History (381)

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New Records of Sarcophagidae from China......Ye Zongmao [5509 1350 5399], Institute of Microbiology and Epidemiology, Academy of Military Medical Sciences, PLA, China (435)

A New Generic Record of Chinese Lizard from Xizang (Tibet)--*Ptyctolaemus gularis* Peters......Huang Yongzhao [7806 3057 2507], Northwest Plateau Biology Institute, Chinese Academy of Sciences (336)

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[Text] On Banach Reductive Operators......Yu Zhishou [0205 5268 1108], Department of Mathematics, Mathematics Institute, Jilin University (11)

The Asymptotic Expansions of the Solutions of a Class of Singular Perturbation Boundary Value Problems......Zhou Qinde [0719 2953 1795], Department of Mathematics, Mathematics Institute, Jilin University (26)

K-Homology of Homogeneous Spaces and Classical Groups...... He Baihe [0149 0130 0735], Department of Mathematics, Mathematics Institute, Jilin University (42)

A Kind of Invertible Graphical Process for Finding Reciprocal Formulas with Applications......Xu Lizhi [1776 0448 3112], Computational Mathematics Teaching and Research Group, Department of Mathematics; Jiang Maosen [5592 5399 2773], Probability and Statistics Teaching and Research Group, Department of Mathematics (55)

Lock Semantic Resolution Principle in Special Fuzzy Logic...... Liu Xuhua [0491 0650 5478], Department of Computer Science (60)

On Linear Automata (III)......Guan Jiwen [4619 4764 2429], Department of Computer Science (78)

An Investigation on the Effect of the Catalytic Alloys Containing Small Amounts of Elements on the Synthesis under High Pressure and High Temperature......Teaching and Research Section of Solid State Physics, Jilin University; Shenyang Non-ferrous Metal-working Plant; Harbin Grinding Wheels Plant; Changchun Institute of Physics, Chinese Academy of Sciences (86)

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[Text] Dual Spline Interpolation (I)......Li Yuesheng [2621 1471 3932], Computer Science Department (1)

The Method of Finite Propagation of Waves......Wu Ciqian [0702 5417 3383], Computer Science Department (11)

The Finite Element Method for Four Order Differential Equation Systems with Variable Coefficients......Ma Runian [7456 3067 1819] and Chen Baoyao [7115 1405 5069], both of the Department of Mathematics and Mechanics, Zhongshan University; Liu Hongkai [0491 1347 7030], Guangdong Transportation and Communication Study Group (18)

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Study of π -Complexes Formed from Maleic Anhydride with Potassium Phenoxides......Xu Xiangong [1776 6343 1872] and Ying Baining [5391 0130 1380], both of the Department of Chemistry (39)

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Synthesis of a New Insect Anti-juvenile Hormone Mimic, 7-(6.7-epoxy-3.7-dimethyl-2-octenoxy)-2.2-Dimethylchromene......Li Ruisheng [2621 3843 5116], Gan Xin [3927 2450], Liu Yongjian [0491 3057 1017], Zhu Fangxiang [2612 2455 4383] and Lin Qiongfang [2651 8825 5364], all of the Department of Chemistry (51)

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Discussion on the Circular Pattern on Spore Walls of Zygnemataceae ......Zhu Wanjia [2612 1238 0857], Department of Biology (80)

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Effect of the Flavanoids Isolated from Dermodium styracifolium on the Cardio-cerebrovasculum......Xu Shibo [6079 1395 3134], Physiology Teaching and Research Group, Department of Biology; Qiu Chenbo [8002 2525 3134], Zhong Ruyun [6945 1172 5366], Liang Qunhuan [2733 5028 2970] and Xian Shunying [0405 7311 5391], all of the Scientific Research Group, Traditional Chinese Medicine Plant No 9, Guangzhou (98)

Total Solar Radiation and Its Latent Production Forces in Guangdong......Huang Weifeng [7806 0251 1496] and Shen Xueping [3088 7185 5393], both of the Meteorology Department (103)

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A Note of Calculation for Axially Symmetrical Optical Resonators Based on a Matrix Theory for the Diffraction by Plane Screens...... Li Xianshu [2621 0341 2873], Department of Physics; Chen Zhitian [7115 1807 1815], Computer Science Department; Gao Yanqiu [7559 3601 3808], Department of Physics (121)

Preliminary Experiments on the Use of Bacillus thuringiensis
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all of the Institute of Entomology (123)

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Determination of Subsurface Electromagnetic Absorption Profiles --A Method for Geometrical Digital Imaging......Wu Rushan [0702 1172 1472] and Xu Shaohui [1776 7300 6540], both of the Geophysical Exploration Institute, Ministry of Geology (10)

A Vertical Magnetic-Dipole Electromagnetic Sounding Technique in the Frequency Domain (continued)......Liu Zhenduo [0491 2182 6995] and Shi Weixiong [4258 4850 3574] (16)

Geochemical Characteristics and Anomaly Zoning of a Porphyry Copper Deposit in Anhui Province......Porphyry Copper Section of the Geochemical Department, Institute of Geological Research, Ministry of Metallurgy; Geochemical Prospecting Section of the 327 Geological Group, Geological Bureau of Anhui Province (22)

Cluster Analysis of Acidic-Intermediate Small Intrusive Bodies in the Eastern Chinling Area......Fourth Geological Group, Geological Bureau of Henan Province (31)

Application of Geophysical Methods in Geothermal Exploration...... Jia Lingxi [6328 5376 1585] (37)

Application of Fuzzy Algorithm in Cluster Analysis......Yu Bochang [0151 0130 1603] and Xie Xuejin [6200 1331 6930] (41)

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AUTHORS: YUEH Junbao [2867 0193 1405]
LIU Meishan [0491 5019 1194]

ORG: None

TITLE: "Testing Under Severe Cold and At High Altitude"

SOURCE: Beijing HANGKONG ZHISHI [AERONAUTICAL KNOWLEDGE] in Chinese No 1, Jan 81 pp 2-3

ABSTRACT: This article describes the activities of a test team whose mission is to test the performance of a certain Chinese-made turboprop engine under extremely low temperature conditions and at very high altitudes. The low temperature test was conducted over a city (H) in northern China where the temperature was minus 30 degrees Celsius; the high altitude test was conducted over the Tibet highlands where the elevation is 3,500 m above sea level. The engine passed both tests with satisfactory results.

AUTHORS: LIU Kan [0491 0170]
XIAO Guang [2556 0342]

ORG: None

TITLE: "The Mystery of Stealth Airplane"

SOURCE: Beijing HANGKONG ZHISHI [AERONAUTICAL KNOWLEDGE] in Chinese No 1, Jan 81 pp 9-10

ABSTRACT: Stealth airplane is a specially designed airplane which minimizes the reflection of radar returns so it can be "invisible" to enemy search radars during an attack. Specifically, a stealth airplane has several unconventional design features: (1) smoothed profile connecting the wings and the fuselage; (2) mounting of engine inlets on top of fuselage to avoid reflection of radar waves; (3) embedded pilots cabin inside the fuselage; (4) V shaped tail design to enhance scattering of radar waves; (5) "transparent" wings coated with wave-absorbing materials; (6) use of turbofan engine and infrared filter to minimize infrared radiation; (7) use of new composite structural materials capable of absorbing electromagnetic waves.

AUTHOR: WANG Zhanwu [3769 2182 2976]

ORG: None

TITLE: "Wave Absorption and Stealth Airplane"

SOURCE: Beijing HANGKONG ZHISHI [AERONAUTICAL KNOWLEDGE] in Chinese No 1, Jan 81 pp 10-11

ABSTRACT: Recently, after more than 20 years of research, the Secretary of Defense of the United States announced the successful development of a stealth airplane which can effectively deny radar detection. The exact technique used on this airplane remains a secret; however, some of the known "stealth" techniques are: (1) designing the airplane profile to scatter incident radar waves and to reduce radar cross section; (2) coating the airplane with wave-absorbing materials which may be radioactive isotopes, plastic foam, or ferrous oxides; (3) replacing the metallic structure and parts of a conventional airplane by plastic and nonmetallic absorbing structures.

AUTHOR: CAI Shanyu [5591 0810 6877]

ORG: None

TITLE: "Nuclear Battery and Its Application in Space"

SOURCE: Beijing HANGKONG ZHISHI [AERONAUTICAL KNOWLEDGE] in Chinese No 1, Jan 81 pp 19-21

ABSTRACT: Nuclear battery is an energy source in which heat is generated from the decay of radioactive isotopes and is directly or indirectly converted into electricity. The main components of a nuclear battery consist of the radioactive isotope and an energy conversion device. Because of its compact structure, reliable performance, and ease of operation, the nuclear battery has been used as an important energy source in many space applications. In particular, it has been used as the energy source for: (1) artificial earth satellites such as navigation satellites, weather satellites, communication satellites; (2) lunar observation stations; and (3) sensors on interplanetary vehicles such as the Pioneer-10, Pioneer-11, and the Voyager-1, Voyager-2 spacecraft.

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AUTHOR: YANG Shengchang [2799 5116 2490]
ZHANG Guiying [1728 5050 5391]

ORG: None

TITLE: "Infrared Red Sound Transmission Equipment"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 4, 80 pp 8-9

ABSTRACT: Application of infrared technology in sound transmission is a development of recent years. To date, not a few new products have been introduced in this new field. This paper gives a simple explanation of the work principle and introduces several products. The authors are listed at the end of the paper as editors and translators of this paper, but nowhere does it mention the original source of the paper or its contents. There is also no mention of any development of the field in China.

AUTHOR: BAO Xinfu [0545 2450 4395]

ORG: None

TITLE: "Reliability of Magnetic Core Reader-Memory"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 4, 80 pp 14-16

ABSTRACT: The DJS-112 is a small computer using micro-programming control technique. It requires a reader-memory to store the micro-instruction and the initial lead program, with technical requirements of 192 character x 32 digit storage capacity, 2.4 microsecond long cycle and 1.2 microsecond short cycle work speed, a read out time of less than 300 millimicrose, and a high reliability. Taking into consideration the condition of materials and the requirement of economy, the author and colleagues selected pre-wired magnetic core memory parts. The logic structure of the memory unit is described.

AUTHOR: YANG Ruiting [2799 3843 0080]

ORG: None

TITLE: "Several Problems Concerning Long Distance Network and Long Distance Switching Design"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 4, 80 pp 22-25

ABSTRACT: With the development of communication technology and communication equipment, long distance telophony is developing from manual relay to automatic relay so as to practice automatic dialing of long distance telephone calls between cities. To date, this has been accomplished partially in 8 cities in China. During peak hours, the automatic switching system is taking over about 40 percent of the long distance calls in these cities. After 2 years of efforts, a number of technical problems have been resolved and the quality is improving. The design and the problems of the long distance automatic switching system are discussed.

AUTHOR: LIU Junang [0491 0689 2491]
YIN Jiaxiang [1438 0857 4382]

ORG: None

TITLE: "Method of Applying TTL Intermediate Scale Integrated Circuit"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 4, 80 pp 26-28

ABSTRACT: This paper introduces the general method of applying the TTL intermediate scale series circuits. Products of this series belong to the line of choice parts of the Fourth Ministry of Machines, forty some in number, including some key components of computers and industrial control systems. They are designed to be interchangeable with domestic and foreign products of the same types. The structure of the TTL intermediate scale circuit, the basic electrical parameters and symbols, the packaging specifications, and inspection procedures at the plant are described.

AUTHOR: XU Guizhen [1776 2710 3791]
WANG Xiaojuan [3769 5135 1227]
CHEN Dexiao [7115 1795 1321]

ORG: None

TITLE: "National Tungsten, Molybdenum Symposium Held in Shanghai"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 4, 80 inside front cover

ABSTRACT: The National Tungsten Molybdenum Symposium was held in Shanghai under the joint auspices of China Society of Electronics, China Society of Metals, and China Society of Light Industry, 15-21 Jan 80. The Shanghai Municipal Society of Electronics was in charge of organizing the meetings, with the asistance of the Shanghai Light Bulb Plant and Shanghai Institute of Electronic Vacuum Components. A total of 170 delegates representing 76 research, manufacturing, and users of tungsten and molybdenum materials attended, and 42 papers were received. China has been known to be the first and the second in the world in tungsten and molybdenum reserves respectively, but the tungsten and molybdenum products do not meet the quality requirements of domestic electronic industries. The delegates repeatedly discussed the problems and proposed plans to meet the quality requirements of the domestic market by the end of 1980. The advanced quality level of the international market is targeted at the end of 1982. Meanwhile, the state's standard for tungsten filament made in China is arranged and measures are adopted to develop test procedures.

AUTHOR: MENG Kan [1322 0170]

ORG: None

TITLE: "Microwave Remote Sensing"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 5, 80 pp 1-5

ABSTRACT: Microwave remote sensing utilizes either natural microwave radiation or artificially emitted microwave to interact with a given material object or phenomenon for the purpose of determining the condition of the target by measuring the intensity of radiation and the degree of the interaction. The microwave frequencies used in microwave remote sensing are lower than those of visible light and infrared ray, at about 300 megahertz to 300 kilomegahertz. Major microwave remote sensing instruments and the physical bases of various applications of microwave remote sensing technology are discussed.

AUTHOR: CHENG Changfu [4453 7022 4395]

ORG: None

TITLE: "Application of Micro Channel Technology in Electron Beam Devices"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 5, 80 pp 10-15

ABSTRACT: Microchannel Plate [MCP] is a product of union and osmosis of glass fiber technique and modern electronics. The plate consists of extremely small cylinder-shaped electron multipliers mounted side by side to provide image intensification factors as high as 100,000. This paper introduces the basic concept and theory of MCP and its applications as an image intensifier of night-vision instruments, weak light television camera tube, wide band oscilloscopes. The condition and prospect of applications of MCP in photoelectric and electron beam devices are discussed.

AUTHOR: CAO Fangrun [2580 5364 3387]

ORG: None

TITLE: "Research to Make the DP6-3 Dual Audio Frequency Modulation Remote Control Device"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 5, 80 pp 21-25

ABSTRACT: The DP6-3 remote control device is composed of the 2 parts of transmitter and receiver and may be used to proceed with radio control of cranes, hoists, etc. in a distance of 100 m. With it the operator may be prevented from working in environments of high temperature and those containing poisonous gases, dust, and other harmful substances. The structure and circuits of the instrument and the technique of improving the frequency stability are discussed.

AUTHOR: ZHANG Weijing [1728 4850 4842]

ORG: None

TITLE: "DCW-2 Electrically Tuned Superheterodyne Television Sound Track"

SOURCE: Shanghai DIZNZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 5,80 pp 35-36

ABSTRACT: DCW-2 electrically tuned superheterodyne television sound track is manufactured by Zunyi Electron Tube Plant. It can be used to receive 96.2 megahertz frequency modulation radio programs as well as the sound track of channel 5 and channel 8 television programs. The input circuit, the high frequency amplifier, the intermediate frequency amplifier, frequency detection, etc. of this receiver are described.

AUTHOR: LI Ouru [2621 2962 0320]
BAO Yucheng [0545 5940 2052]

ORG: None

TITLE: "A Brief Discussion of the Condition and Developmental Trend of Shortwave Communication in Foreign Countries"

SOURCE: Shanghai DIAN JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 6,80 pp 1-3

ABSTRACT: Shortwave communication has had a history of more than 60 years but due to the fact that electromagentic transmission is influenced by the ionosphere it is not yet sufficiently stable. Improvements, such as high gain directional antenna, made the reception much better, and shortwave communication developed very fast in the 1940's and 1950's. As the number of users increased, the shortwave frequency channels became very crowded and interference became a serious problem, while ocean cable and satellite communication gradually replaced the shortwave for many users. In the past decade, the development of frequency synthesis technique has created a favorable condition for automatic tuning and remote control of shortwave equipment and wide band, electronic control, and electronic computer have also been applied in shortwave communication. This paper discusses these and other aspects of development of shortwave communication in foreign countries.

AUTHOR: SHI Qinglin [2457 1987 7792]
SHI Zhendong [2457 7201 2639]
QIU Meiyu [6726 2734 3768]
TANG Renyu [3282 0088 3768]

ORG: All of Shanghai Institute of Silicates

TITLE: "Photoconductive Fiber Pulse Response Testing"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 6,80 pp4-8

ABSTRACT: Transmission width or the extension width of pulse just as transmission loss is an important parameter of photoconductive fibers. It reflects the information delivery capacity of the photoconductive fiber. In recent years, technological advancement in foreign countries has reduced the fiber loss to the minimum, and testing work of the photoconductive fiber property is concentrated on the aspect of its transmission width and many testing methods have been established. Most of these may be included in the 2 categories of time realm testing method and frequency realm testing method. The former can directly reflect the pulse distortion condition after transmission through the fiber, but the test result must be processed electrically or mathematically before obtaining the transmission band width. For the purpose of meeting the needs of studying the gradient type optical fiber, the authors made a pulse response testing device to use the time realm testing method to determine the transmission band width and the transmission delay time of photoconductive fibers.

AUTHOR: KE Wenxian [2688 2429 2009]

ORG: None

TITLE: "International Communication Satellites"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 6,80 pp9-12

ABSTRACT: Since the first synchronous communication satellite was launched in Apr 65, more than 90 such satellites have been successfully launched by various countries of the world and more than 40 are currently orbiting. The international communication satellite organization now involves more than 100 countries to form a global telephone and television communication network. The history of the first, second, third, fourth, and fifth generation (IS-I, II, III, IV, V) is told. The second part of the paper describes the process of launching a synchronous satellite into orbit.

AUTHOR: ZHU Mengxiong [2612 1125 3574]
CHEN Huikang [7115 1920 1660]
CHEN Hongbi [7115 7703 3880]
WANG Zhiyuan [3769 1807 6678]

ORG: ZHU, CHEN of Communications Division, Shanghai Railway Bureau; CHEN, WANG of Department of Telecommunications, Shanghai Railway College

TITLE: "TTH-1 Carrier Wave Pass Characteristic Automatic Testing Machine"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 6,80 pp13-17

ABSTRACT: At present, testing of carrier wave pass characteristic is done in China basically manually. In order to change this backward condition, the Communications Division of Shanghai Railway Bureau and the Department of Telecommunications of Shanghai Railway College jointly made the TTH-1 carrier wave pass characteristic automatic testing machine. It is a digital, integrated, continuous operation automatic testing machine, suitable for daily monitoring. The test items, the major technical properties, and the components of this testing machine are described.

AUTHOR: WANG Ziting [3769 3320 1656]

ORG: Shanghai Electrical Meter Plant

TITLE: "Applications of Analogue Magnetic Tape Recorder"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 6,80 pp 27-29

ABSTRACT: Magnetic recording is an important branch of electronic technology. It is used to record sound, images, external storage of computers, analogue data recording, etc. The analogue magnetic recorder is a recorder of analogue data using magnetic tape as the storage medium. This paper explains the various applications of analogue magnetic tape recorder and the various ways in which it is different from an ordinary sound recorder.

AUTHOR: ZHANG Jian [1728 0494]

ORG: None

TITLE: "10 kw All Transistor Highly Stable Power Source"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 6,80 pp34-37

ABSTRACT: This paper introduces an all transistor large power, stable voltage, stable current electrical power source. The design output is 9.6 kw and actual output may exceed 10 kw. The maximum output voltage is above 160 v. The currect may be regulated within the limit of 0.5-60 A. Problems relating to its designing process, the selection of its key components, and computation and analysis of its circuits are discussed.

AUTHOR: ZHOU Tongsheng [0719 0681 4141]

ORG: None

TITLE: "Time-Programmed Control Device"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 6,80 pp44,8

ABSTRACT: The time programmed control device is often adopted in industrial production for automatic operation. It is very useful in electroplating and battery making when the work environment is either poisonous or under high temperature conditions. This paper describes the basic circuit of the time-programmed control device, composed of silicon controlled switches. Due to the fact that inexpensive silicon controlled switches are not easily available, a second circuit is given. It is of similar theory but slightly more complicated. In this second circuit, transistors are used to replace silicon controlled switches.

AUTHOR: MU Ganqi [4476 1626 0967]

ORG: None

TITLE: "New Developments in High Fidelity Audio Amplifiers"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 6, 80 p 47

ABSTRACT: Most recently, 2 new circuits have been developed to improve the result of sound amplification to cause the sound to be more real and more pleasing to the ear. One is the on site audio effect control circuit and the other is the sound source surface stereo effect control circuit. This paper explains these circuits and their applications.

AUTHOR: CHEN Renfu [7115 0088 3940]
DENG Mingwan [6772 0682 8001]

ORG: None

TITLE: "Trends of Computer System Structures"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 7, 80 pp 1-4

ABSTRACT: From vacuum tubes to transistors to integrated circuits, electronic computers have grown through 3 generations. Currently, it has entered the 4th generation of large scale integration (LSI) computers and with LSI, the function of computers doubles every year while at the same time, the cost of computers is cut into half. Micro-processors will ultimately replace small computers; LSI storage unit has completely replaced the magnetic core memory; the price of soft magnetic disk is being reduced 35 percent per year to cause it to be extensively used as an external storage equipment. These developments and their future possibilities are discussed.

AUTHOR: WANG Wenguang [3769 2429 0342]

ORG: None

TITLE: "Computer-aided Testing Technique for Integrated Circuits--The RAM Test of ECL-256 Digit"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 7,80 pp15-17, 14

ABSTRACT: With the development of large scale integrated circuits, it is more and more urgently felt that computer should participate in the designing, research, and manufacture of large scale integrated circuits. The goal is to use computers to achieve automation or semi-automation. There are so many items to be tested in large scale integrated circuits that manual testing is becoming virtually impossible. This paper explains the contents of the computer-aided test system and its actual application, related RAM test, and its function identification circuit.

AUTHOR: GAO Jinxin [2580 6930 7451]

ORG: Designing Department, Shanghai Radio Plant No 3

TITLE: "A New Type Audio Frequency Power Amplification Circuit"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 7, 80 pp 39-42, inside front cover

ABSTRACT: Ordinary battery operated transistor radio receivers and sound recorders generally have 2 types of audio frequency power amplification circuits: the typical transformer coupled power amplification circuit and the OTL circuit. These two are often not satisfactory if high fidelity is desired under the condition of relatively low voltage. This paper introduces a circuit similar to the OTL designed by the author and colleagues in 1974. Using the power amplifier of the Chunlei-3H5 pocket radio as an example, the work theory of this circuit is explained. The property characteristics of this circuit are also compared with those of the OTL circuit.

AUTHOR: None

ORG: Shanghai Radio Plant No 26

TITLE: "TF8 Microwave Coaxial Reflecting Meter"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 7, 80 p 46

ABSTRACT: The TF8 microwave coaxial reflecting meter produced by the Shanghai Radio Plant No 26 is a frequency scanning instrument for testing the reflex characteristics of coaxial components within the frequency band of 8-12.4 kilomegahertz. When it is assembled with a signal generator and an oscillograph, it may be used to observe and record the standing wave ratio of the tested instrument in the entire frequency band. The technical parameters and the work theory of this test instrument are described.

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CSO: 4009

AUTHOR: LIU Shaoqiu [0491 4801 3808]

ORG: None

TITLE: "A New Departure, the Modular Rocket"

SOURCE: Beijing KEQUE SHIYAN [SCIENTIFIC EXPERIMENT] in Chinese No 12, 1980 pp 10-11

ABSTRACT: In the summer of 1977 West German rocket engineers launched a new type of rocket in Zaire. This rocket was modular, built from standardized industrial components, which made it cheap to produce. Individual rocket propulsion units consisting of a combustion chamber, nozzle, valve and electronic control unit and measuring 0.3 meters in diameter and up to 40 meters long were grouped together in bundles to form each stage of the rocket. Kerosene and nitric acid are used as fuel, lowering costs and obviating the problems involved in handling more exotic fuels and oxidizers. The rocket's course is controlled by controlling which of the propulsion units are firing at a given moment. The valves which control the individual nozzles are operated by mass-produced windshield wiper motors. The modular rockets are cheap and can be used for launching satellites, orbital space stations and other space vehicles. Their main disadvantage is that they are extremely bulky compared with more sophisticated types of rockets, but the field is still in its infancy.

AUTHOR: XU Desheng [1776 1795 0524]

ORG: None

TITLE: "Nuclear Power Plants on Board Satellites"

SOURCE: Beijing KEXUE SHIYAN [SCIENTIFIC EXPERIMENT] in Chinese No 12, Dec 80 pp 30-32

ABSTRACT: In order to observe increased US naval movement in the Indian Ocean following the Soviet invasion of Afghanistan, a Kosmos 954 satellite was launched on 21 April 1980. The satellite is similar to the one which fell on Canada in 1977. The powerful radars of these satellites receive their electricity from an on-board nuclear power plant via a thermoelectric generator. The kosmos 954's power plant contains 49 kg of uranium oxide and can reach a temperature of 1770° C. The silicon-germanium thermoelectric cells which it powers are capable of putting out 500-800 watts. When the earlier Kosmos 954 fell on Canada, its nuclear unit was supposed to be ejected into outer space, but the mechanism failed. The United States SNAP-10A satellite power unit uses a liquid sodium-potassium mixture as a coolant and its lower section contains 2,880 germanium-silicon thermocouples mounted on 120 coolant tubes. The unit can put out 540 watts at 28.5 V and 19 amperes, with a generating efficiency of 1.43%. An increase in the temperature can yield outputs as high as 1,200 W. The unit contains 4.3 kg of ^{235}U. [illegible] lifetime is over 10 years at 540 watts.

AUTHOR: CHEN Baoyi [7115 1405 5030]

ORG: None

TITLE: "A Tracking-Type Solar Heater"

SOURCE: Beijing KEXUE SHIYAN [SCIENTIFIC EXPERIMENT] in Chinese No 12, Dec 80 p 35

ABSTRACT: Two Australians have developed a solar heater unit which automatically tracks the sun, using only the pressure from a household water system as a source of motive power. The unit is shaped approximately like a half oil drum pivoted along its axis. Air-filled tubes are mounted along its eastern and western edges. When the device is not correctly oriented toward the sun, the air in one of the tubes will be heated more than the other; the pressure differential, operating through a membrane and rod assembly, opens or closes a hydraulic valve which actuates the mechanism to rotate the device in the proper direction, orienting it more correctly toward the sun. At the end of the day the device rotates back toward the east. The reflector, with a parabolic cross section, is 6.5 feet long, and 2.3 feet wide. A heat pipe containing a small amount of water runs down the focus and the steam produced when the pipe is heated by the sun's rays is transferred to water in a 175 gallon tank, via a coil.

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CSO: 4009

AUTHOR: YU Hui [6735 8748]

ORG: None

TITLE: "Polypropylene: A New, Elegant Chemical Fiber"

SOURCE: Beijing XIANDAIHUA [MODERNIZATION] in Chinese No 8, 16 Aug 80 pp 2-3

ABSTRACT: Polypropylene, one of the newest chemical fibers, first went into production in Italy in 1957. Current total world production is estimated at about 1.3 million tons. Its production offers advantages to China, which produces 1 130,000 tons of byproduct propylene for every 300,000 tons of ethylene; much of this used to be burned. After purification it can be used immediately for production of fiber. Its production cost is about a third that of polyamide. It produces little pollution during production and requires little energy. Polypropylene fiber is less dense than water and than other fibers such as polyester and nylon. Accordingly when used in carpet it covers a much greater area per unit weight. In addition, its insulating ability per unit weight is much greater than that of other synthetics. In addition to industrial uses stemming from its acid and water resistance, its ability to absorb more than 10 times its weight of oil is important in oil recovery technology. It has certain disadvantages in clothing production, primarily the fact that it ages easily and is difficult to dye. But energetic research is under way to increase its usefulness in cloting production, and polypropylene fabrics and clothing are already being produced in China.

AUTHOR: QU Guangji [3575 1639 0679]

ORG: None

TITLE: "May I Ask, Satellite, Where I Am?"

SOURCE: Beijing XIANDAIHUA [MODERNIZATION] in Chinese No 8, 16 Aug 80 pp 4-5, 9

ABSTRACT: The discovery in 1957 of a Doppler effect in signals received from satellites led to the development of the Transit series of navigation satellites, the first of which was launched in October 1960. Six of these satellites flying in polar orbits 1,000 km high with a period of 109 minutes emitted signals at 150 and 400 MHz. Users on the earth's surface could determine their position to within 40 meters using the signal; if several passes were used, the accuracy could be increased to within 10 meters. In the second series of navigation satellites, the NAVSTAR system, a total of 24 satellites in 3 separate orbits (8 per orbit) will circle the earth at about 20,000 km with a period of 12 hours. TUese satellites will have atomic clocks for precise timing. A receiver equipped with an atomic clock which receives signals from 3 of these satellites can determine its position within 10 meters, and a unit which can receive signals from 4 of the satellites will not need an atomic clock. This systeh allows determination not only of latitude and longitude, but also of altitude and speed. Thus it can be used not only by ships but by aircraft and rockets, as well as tanks and individual soldiers. Determinations can be made in a matter of seconds. Five of the satellites are currently in orbit.

AUTHOR: ZHANG Liangbi [1728 5328 1732]

ORG: Beijing Municipal Office of Geology

TITLE: "Manmade Gas Fields That Outdo Nature"

SOURCE: Beijing XIANDAIHUA [MODERNIZATION] in Chinese No 8, 16 Aug 80 pp 26-27

ABSTRACT: In 1979 the author made a fact-finding trip to France to inspect gas storage fields. By 1978 France already had 9 of these storage areas, with a total capacity of more than 7 million cubic meters of gas and a recoverable volume of over 3.3 billion cubic meters, equivalent to 16 percent of France's natural gas sales that year. There is a total of 156 wells with a total daily withdrawal capacity of 7,000 cubic meters. The firlds are integrated into the French gas pipeline system. The most common gas storage method is to pump the gas under pressure into trap structures consisting of a porous water-bearing rock covered by an impermeable stratum; this is usually a worked-out oil pool. The water in the rock seals the gas in from underneath and the impermeable cap rock holds it in from above. A number of wells are sunk into this structure in order to manage the flow effectively. A gas purification plant is also required. The French are also storing gas in salt deposits. Water is first pumped in, dissolving some of the salt and leaving a cavity, into which the gas is pumped. The gas is removed by pumping in salt water. Computerization of the gas storage facilities makes it possible for them to be operated by very small crews.

AUTHOR: JIANG Ping [1203 1627], CHEN Xiaobo [7115 5135 2672]

ORG: Lanzhou Institute of Glaciology and Cryopedology, Chinese Academy of Sciences

TITLE: "Frozen Soil Assists Civil Engineers"

SOURCE: Beijing XIANDAIHUA [MODERNIZATION] in Chinese No 8, 16 Aug 80 pp 38-39

ABSTRACT: Soil is friable, plastic and water-permeable and has a poor resistance to pressure. But its strength increases as the temperature falls below freezing, exceeding 30 kilometers per cm^2 at -10° C. At these low temperatures civil engineering work is rendered much easier.by the fact that the soil holds its shape and dies not allow water to percolate through it into excavations. In some cases soil at civil engineering sites can be frozen artifically using a technique first attempted in England in 1862 and adopted in China in 1959. A coolant is first compressed to form a liquid, than cooled and allowed to expand into cooling tubes embedded in the soil which is to be frozem. It removes the heat from the soil, turning into a gas and returning to the compressor for recycling. The soil around an excavation site, e.g. for a pier, is frozen by insertion of the colling tubes in a circular pattern, creating an area of frozen soil around the site, where drilling or blasting can then be used.

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